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BULLETIN

DE LA

SOCIÉTÉ FOUAD Ier D'ENTOMOLOGIE

FONDEE LE 1er AOUT 1907

anciennement:

Société Entomologique d'Egypte (1907-1922)
et *Société Royale Entomologique d'Egypte* (1923-1937)

Placée sous le Haut Patronage du Gouvernement Egyptien
par Décret Royal en date du 15 Mai 1923

Année 1941

LE CAIRE
IMPRIMERIE P. BARBEY
—
1941

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SOCIÉTÉ FOUAD Ier D'ENTOMOLOGIE

TRENTE-QUATRIÈME ANNÉE

VINGT-CINQUIÈME VOLUME

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Les opinions émises dans les publications de la Société sont propres à leurs auteurs. La Société n'en assume aucunement la responsabilité.

Date de parution et de distribution du présent Volume :
31 Décembre 1941

Le Rédacteur en Chef :
A. ALFIERI

DÉCRET DONNANT LE NOM DE FOUAD PREMIER A DES INSTITUTIONS PUBLIQUES CRÉÉES SOUS SES AUSPICES [1]

Nous, FAROUK Ier, Roi d'Egypte,

Sur la proposition du Président de Notre Conseil des Ministres tendant à perpétuer le souvenir de feu le Roi Fouad Premier et à glorifier son nom, vu que son règne s'est distingué par des œuvres éminentes dans le domaine des réformes et par la création de maintes institutions publiques dont la réalisation s'est accomplie grâce à ses conseils et à sa sollicitude, ce qui a eu la plus grande influence sur l'orientation et le développement de la renaissance scientifique, littéraire, sociale et économique de l'Egypte;

Sur l'avis conforme de Notre Conseil des Ministres;

DECRETONS

Art. 1. — Le nom de Fouad Premier est donné aux institutions et établissements indiqués au tableau annexé au présent décret. [2]

Art. 2. — Le Président de Notre Conseil des Ministres est chargé de l'exécution du présent décret, qui entrera en vigueur dès sa publication au « Journal Officiel ».

Fait au Palais de Montazah, le 11 Gamad Tani 1357 (7 Août 1938).

FAROUK

Par le Roi :
Le Président du Conseil des Ministres p.i.
ABDEL FATTAH YÉHIA

(Traduction)

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(1) Extrait du *Journal Officiel* du Gouvernement Egyptien, N° 94, du Jeudi 11 Août 1938.

(2) Parmi ces institutions et établissements, figure, sub 7 : *Société Fouad Ier d'Entomologie* **au lieu de** *Société Royale Entomologique d'Egypte.*

DÉCRET NOMMANT LE PRÉSIDENT DE LA SOCIÉTÉ FOUAD Ier D'ENTOMOLOGIE (1)

Nous, FAROUK Ier, Roi d'Egypte,

Vu le Décret du 15 Mai 1923 approuvant les Statuts de la Société Royale d'Entomologie d'Egypte (Société Fouad Ier d'Entomologie) ;

Sur la proposition du Président de Notre Conseil des Ministres et l'avis conforme du dit Conseil ;

DECRETONS

Art. 1. — Mahmoud Tewfik Hifnaoui Bey, Ministre de l'Agriculture, est nommé Président de la Société Fouad Ier d'Entomologie.

Art. 2. — Le Président de Notre Conseil des Ministres est chargé de l'exécution du présent décret.

Fait au Palais d'Abdine, le 6 Moharram 1359 (14 Février 1940).

FAROUK

Par le Roi :
Le Président du Conseil des Ministres,
ALY MAHER

(Traduction)

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(1) Extrait du *Journal Officiel* du Gouvernement Egyptien, 67ème année, N° 18, du Lundi 19 Février 1940.

MEMBRES BIENFAITEURS
DE LA SOCIÉTÉ FOUAD Ier D'ENTOMOLOGIE

1924 M. Moustapha El Salanikli Bey, de Damanhour (Béhéra).

1925 S.E. El Sayed Fathalla Mahmoud Pacha, de Rahmania (Béhéra).

» M. Riad Abdel Kawi El Gebali Bey, de Chebin El Kom (Menoufia).

» S.E. Georges Wissa Pacha, d'Assiout (Haute-Egypte).

» M. Yehia Kawalli Bey, de Minieh (Haute-Egypte).

» M. Yacoub Bibawi Attia Bey, de Minieh (Haute-Egypte).

» S.E. Hassan Charawi Pacha, de Minieh (Haute-Egypte).

» S.E. Habib Chenouda Pacha, d'Assiout (Haute-Egypte).

» M. Mohamed Tewfick Mohanna Bey, de Tewfikieh (Béhéra).

» M. Hassan Ahmed Moussa Bey, de Minieh (Haute-Egypte).

» M. Labib Barsoum Hanna Bey, de Minieh (Haute-Egypte).

» S.E. Hassan Mohamed El Tahtawi Pacha, de Guirgheh (Haute-Egypte).

» M. Kassem Osman El Labban Bey, de Guirgheh (Haute-Egypte).

» M. Dordeir El Sayed Ahmed El Ansari Bey, de Guirgheh (Haute-Egypte).

» M. Barsoum Said Abdel Messih Bey, de Minieh (Haute-Egypte).

» M. Dordeir Taha Abou Gounema Bey, de Minieh (Haute-Egypte).

1926 M. Mohamed Rifaat El Roznamgy Bey.

1927 M. le Dr. Walter Innes Bey, (décédé en 1937).

» M. le Dr. Avocat Giovanni Ferrante, du Caire.

1928 M. le Professeur Hassan C. Efflatoun Bey, du Caire.

» M. Hugo Lindeman, (décédé en 1937).

1932 M. Alfred Reinhart, (décédé en 1935).

ORGANISATION ADMINISTRATIVE POUR L'ANNÉE 1941

Membres du Conseil

M. le Prof. Mahmoud Tewfik Hifnaoui Bey, *Président.*

M. le Prof. Hassan C. Efflatoun Bey, *Vice-Président.*

M. Mohamed Soliman El Zoheiry, *Vice-Président.*

M. Anastase Alfieri, *Secrétaire-Général.*

M. Richard Wilkinson, *Trésorier.*

S.E. Fouad Abaza Pacha.

M. le Dr. Mohamed Shafik.

M. le Prof. Dr. Kamel Mansour.

M. Abdel Megid El Mistikawy.

M. le Prof. Dr. Hamed Seleem Soliman.

M. le Dr. Saadallah Mohamed Madwar.

M. Edgard Chakour.

Comité Scientifique

M. le Prof. Hassan C. Efflatoun Bey, M. le Prof. Dr. Kamel Mansour, M. le Dr. Mohamed Shafik, M. le Prof. Dr. Hamed Seleem Soliman, M. le Dr. Saadallah Mohamed Madwar, M. Mohamed Soliman El Zoheiry, M. Anastase Alfieri.

Censeurs

M. le Dr. A. Azadian et M. E. Kaourk.

LISTE DES MEMBRES

DE LA

SOCIETE FOUAD Ier D'ENTOMOLOGIE

EN 1941

(Les noms des Membres Fondateurs sont précédés de la lettre F)

Vice-Président Honoraire

F — FERRANTE (Dr. Avocat Giovanni), 14, Rue El Nemr, au Caire.

Membres Honoraires

1908 — ALLUAUD (Charles), Les Ouches, à Crozant (Creuse), France.

1924 — EBNER (Prof. Richard), 3, Beethovengasse, Vienne IX, Allemagne.

1909 — MARCHAL (Dr. Paul), 45, Rue de Verrières, à Antony (Seine), France.

1929 — PARENT (l'Abbé O.), Institution Ste Marie, Aire sur la Lys, Pas de Calais, France.

» — PEYERIMHOFF DE FONTENELLE (P. de), 87, Boulevard Saint-Saëns, Alger, Algérie.

1908 — PIC (Maurice), 3, Rue du Pont Neuf, à Digoin (Saône et Loire), France.

1921 — PIERRE (Claude), 7 bis, Rue du Loing, Paris (XIVe), France.

1936 — SEIF EL-NASR Pacha (S.E. AHMED HAMDI), Rue Khosro Pacha, Helouan, près le Caire.

1940 — SILVESTRI (Prof. F.), Ecole Royale Supérieure d'Agriculture, Portici (Naples), Italie.

1929 Théry (André), Laboratoire d'Entomologie, Museum National d'Histoire Naturelle, 45 bis, Rue de Buffon, Paris (V°), France.

1920 Tonnoir (André), Senior Research Officer, Division of Economic Entomology, Council for Scientific and Industrial Research, P.O. Box 109, Canberra, F.C.T., Australia.

» Villeneuve (Dr. Joseph), Rue Président Paul Doumer, Rambouillet (Seine et Oise), France.

F' Willcocks (F.C.), « Brambles », Hurst Lane, Sedlescombe (near Battle), Sussex, Angleterre.

Membres Correspondants

1932 Alfken (J.D.), 18, Delmestrasse, Brême, Allemagne.

» Ballard (Edward), District Commissioner's Office, Jerusalem, Palestine.

1924 Cros (Dr. Auguste), 6, Rue Dublineau, Mascara, Algérie.

1928 D'Orchymont (A.), 176, Avenue Houba de Strooper, Bruxelles (II), Belgique.

1924 Flower (Major Stanley Smyth), Tring, Herts, Angleterre.

1934 Gadeau de Kerville (Henri), 7, Rue du Passage Dupont, Rouen, France.

1926 Hall (Dr. W.J.), Superintendent of the Mazoe Estate and Experimental Station, B.S.A. Company Citrus Estate, Mazoe, Southern Rhodesia, South Africa.

1923 Hervé-Bazin (Prof. Dr. J.), Le Patys, par Segré (Maine et Loire), France.

1924 Hindle (Dr. Prof. Edouard), Magdelene College, Cambridge, Angleterre.

1923 Hustache (A.), Pensionnat St. Laurent, à Lagny (Seine et Marne), France.

1925 Kirkpatrick (Thomas Winfrid), East African Agricultural Research Station, Section of Entomology, Amani (via Tanga), Tanganyika Territory, British East Africa.

1934 Koch (C.), c/o Monsieur Georges Frey, 18, Pienzenauerstrasse, Munich 27, Allemagne.

1929 Masi (L.), Museo Civico di Storia Naturale « Giacomo Doria », 9, Via Brigata Liguria, Genova (102), Italie.

1930 Mellor (J.E.M.), The Prospect Cottage, Bredwardine, Herefordshire, Angleterre.

1934 Paoli (Prof. Guido), Directeur du R. Osservatorio per le Malatie delle Piante, 1, Via Marcello Durazzo, Gênes, Italie.

» Schatzmayr (A.), Museo Civico di Storia Naturale, Corso Venezia, Milano, Italie.

1927 Williams (C.B.), Rothamsted Experimental Station, Harpenden, Herts, Angleterre.

Membres Titulaires

1913 Abaza Pacha (S.E. Fouad), Directeur Général de la Société Royale d'Agriculture, Boîte Postale N° 63, au Caire.

1941 Abou El Fath (Mohamed), Département d'Entomologie, Faculté d'Agriculture, Université Fouad I^er^, Rue El-Madares, Ghizeh, près le Caire.

1923 Agricultural Research Institute (The Librarian), Wad Medani, Soudan.

1908 Alfieri (Anastase), Secrétaire Général et Conservateur de la Société Fouad I^er^ d'Entomologie, Boîte Postale N° 430, au Caire.

1941 Amin El Dib (Abdel Latif), Département d'Entomologie, Faculté d'Agriculture, Université Fouad I^er^, Rue El Madares, Ghizeh, près le Caire.

1938 Attia (Rizk), Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.

1924 Azadian (Dr. A.), Laboratoires d'Hygiène Publique, au Caire.

1938 Bailey Bros and Swinfen Ltd., Cathedral House, 8-11, Paternoster Row, Londres, E.C. 4, Angleterre.

1939 Bechir (Mahmoud), Section de Protection des Plantes, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.

1929 Bichara (Ibrahïm), Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.

1938 Blancheteau (Marcel), Aux Amateurs de Livres, 56, Faubourg Saint-Honoré, Paris (VIII^{e}).

1939 Blaringhem (Louis), de l'Institut de France, Conservateur de l'Arboretum G. Allard, 77, Rue des Saints Pères, Paris (VI^{e}), France.

1923 Bodenheimer (Prof. F.S.), Hebrew University, Jerusalem, Palestine.

1938 Carneri (Alexandre), Librairie Elpénor, 10, Rue Chakour Pacha, Alexandrie.

1929 Cassab (Antoine), Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.

F Chakour (Edgard), Secrétaire Général de la Société Anonyme des Eaux du Caire, Rue Foum El-Teraa El-Boulakia, au Caire.

1931 Compagnie Universelle du Canal Maritime de Suez, 20, Rue Dar El-Chefa, Kasr el Doubara, au Caire.

1934 Crédit Foncier Egyptien (Monsieur l'Administrateur Délégué), Rue Malika Farida, au Caire.

1938 Directorate of Agriculture, Ministry of Economics and Communications, Baghdad, Irak.

1928 Dollfus (Robert Ph.), Museum National d'Histoire Naturelle, 57, Rue Cuvier, Paris (V^{me}), France.

1919 Efflatoun Bey (Hassan C.), Professeur d'Entomologie et Vice-Doyen de la Faculté des Sciences, Université Fouad I^{er}, Abbassieh, au Caire.

1934 Faculté d'Agriculture, Université Fouad I^{er}, Rue El-Madares, Ghizeh, près le Caire.

1941 Fahmy (Aly), Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.

1940 Farghal Aly (Mohamed), 35, Rue Akef, Abbassia, au Caire.

1914 Garboua (Maurice), 1, Rue Soliman Pacha, au Caire.

1938 Ghabn (Dr. Abdel Aziz), Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.

1927 Ghali Pacha (S.E. Wacef Boutros), Avenue de Ghizeh, près le Caire.

1938 Ghesquière (J.), 87, Avenue du Castel, Bruxelles (W. St L.), Belgique.

1921 Greiss (Elhamy), Département Botanique, Faculté des Sciences, Université Fouad I^er^, Abbassieh, au Caire.

1936 Hafez (Dr. Mahmoud), Ph. D., Département d'Entomologie, Faculé des Sciences, Université Fouad I^er^, Abbassieh, au Caire.

1938 Hamza (Soliman), Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.

1930 Hanafy Bey (Mahmoud), 12, Rue Akhshid, Manial El Roda, près le Caire.

1938 Hanna (Dr. Assaad Daoud), Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.

1928 Hassan (Dr. Ahmed Salem), Professeur de Zoologie et d'Entomologie à la Faculté d'Agriculture, Université Fouad I^er^, Rue El-Madares, Ghizeh, près le Caire.

1941 Heath Davies (Madame D. M.), 8, Rue Birgas, Garden City, au Caire.

1940 Hifnaoui Bey (Prof. Mahmoud Tewfik), Président de la Société Fouad I^er^ d'Entomologie, Rue Lazogly, Hélouan, près le Caire.

1932 His Majesty Stationery Office, Princes Street, Westminster, S.W.1, London, Angleterre.

1925 Hocheiry Bey (Abd-El-Baki Zaki El), ancien Conseiller à la Cour d'Appel Indigène, 22, Rue Abou El-Feda, Zamalek, au Caire.

1924 Honoré (Dr. A.), Chimiste, Raffinerie de Hawamdieh, Haute-Egypte.

1927 Housny (Mahmoud), Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.

1938 Ibrahim (Abdel Hamid), Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.

1940 Ibrahim (Ahmed Housny), Section d'Entomologie, Ministère de l'Agriculture, Dokki (Gkizeh), près le Caire.

» Ibrahim Zeid (Mahmoud Mohamed), Département d'Entomologie, Faculté d'Agriculture, Université Fouad I^er^, Rue El-Madares, Ghizeh, près le Caire.

1936 Imperial Chemical Industries (Egypt) S.A., 26, Rue Madabegh, au Caire.

1938 Itribi (Abbas El), Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.

1928 Izzet Bey (Mohamed), 14, Midan El Daher, au Caire.

1915 Jullien (Joseph), 215, Rue de Thèbes, Cléopâtra-les-Bains, Ramleh.

1927 Kamal (Dr. Mohamed), Cotton Research Board, Ministère de l'Agriculture, Rue El-Madares, Ghizeh, près le Caire.

1941 Kamel El Sawaf (Saleh), Département d'Entomologie, Faculté d'Agriculture, Université Fouad I^er^, Rue El-Madares, Ghizeh, près le Caire.

1922 Kaourk (Elias A.), Avocat, c/o Egyptian Markets C^o^ Ltd, 136, Rue Emad El Dine, au Caire.

1926 Kassem (Mohamed), Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.

1938 Klein (Henry Z.), Agricultural Research Station, Rehovoth, Palestine.

1923 Laboratoires d'Hygiène Publique, Bibliothèque de la Section d'Helminthologie, au Caire.

1931 Land Bank of Egypt (Mons. l'Administrateur-Directeur de la), Boîte Postale N° 614, Alexandrie.

1934 Lotte (Dr. F.), Médecin de la Compagnie Universelle du Canal Maritime de Suez, Boîte Postale N° 222, Port-Saïd.

1937 Loutfy (Abdel Aziz), Section de la Protection des Plantes, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.

1931 Lycées Français, 2-4, Rue Haouayati, au Caire.

1932 Madwar (Dr. Saadallah Mohamed), Fouad I[st] Institute and Hospital for Tropical Diseases, 10, Rue Kasr El Aini, au Caire.

» Maluf (Dr. N. S. Rustum), Department of Zoology, The Johns Hopkins University, Charles and 34th Streets, Baltimore, Maryland, Etats-Unis d'Amérique.

1927 Mansour (Prof. Dr. Kamel), D. Sc., Département de Zoologie, Faculté des Sciences, Université Fouad I[er], Abbassieh, au Caire.

1921 Mistikawy (Abdel Megid El), Sous-Directeur de la Section de la Protection des Plantes, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.

1933 Mochi (Prof. Dr. Alberto), Villa i Sarici, Collina, presso Pistoia, Italie.

1940 Mohamed (Ibrahim Nour El Din), B. Sc. (Faculté d'Agriculture, Université Fouad I[er]), 5, Rue Afrah El Anghal, Mounira, au Caire.

1929 Mosseri (Henri), 25, Rue Cheikh Abou El Sebaa, au Caire.

1940 Nour El Din (Ahmed), Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.

1939 Pantos (Jean G.), Ingénieur Agronome, Boîte Postale N° 411, Kampala, Uganda.

1911 Petroff (Alexandre), 27, Rue Grafton, Bulkeley, Ramleh.

1928 Priesner (Prof. Dr. H.), au Caire.

1932 Rivnay (E.), Agricultural Research Station, Rehovoth, Palestine.

1925 Royal Entomological Society of London (The), 41, Queen's Gate, South Kensington, S.W. 7, Londres, Angleterre.

1936 Sayed (Dr. Mohamed Taher), Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.

1938 Shafei (Mohamed Aly Ismail El), 18, Midan Mohamed Aly, au Caire.

» Shafik (Dr. Mohamed), Directeur Technique de la Société Financière et Industrielle d'Egypte, Boîte Postale N° 7, Kafr Zayat, Basse Egypte.

1924 Shaw (Fred), Northgate, Sherborne, Dorset, Angleterre.

1938 Société du Naphte S.A. (A.I. Mantacheff & Co.), 33, Rue Madabegh, au Caire.

1921 Société Royale d'Agriculture, Laboratoire d'Entomologie de la Section Technique, Boîte Postale N° 63, au Caire.

1934 Soliman (Prof. Dr. Hamed Seleem), Faculté d'Agriculture, Université Fouad I^er^, Rue El-Madares, Ghizeh, près le Caire.

1928 Soliman (Dr. Labib Boutros), Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.

1926 Tewfik (Mohamed), Assistant Entomologiste, Faculté des Sciences, Université Fouad I^er^, Abbassieh, au Caire.

1935 Tractor Company of Egypt, S.A.E. (The), 140, Rue Emad El Dine, Boîte Postale N° 366, au Caire.

1926 Waly (Dr. Mohamed), Conférencier en Zoologie, Faculté des Sciences, Université Fouad I^er^, Abbassieh, au Caire.

1912 Wilkinson (Richard), Immeuble Baehler, 157, Avenue Fouad I^er^, Zamalek, au Caire.

1938 Zoheiry (Mohamed Soliman El), Sous-Directeur et Directeur p.i. de la Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.

Institutions Scientifiques et Bibliothèques

Afrique Occidentale Française:

Institut Français d'Afrique Noire, Boîte Postale N° 206, Dakar.

Afrique du Sud:

South African Museum, P.O. Box 61, Cape Town.

Department of Agriculture of the Union of South Africa (The Agricultural Journal of the Union of South Africa), Pretoria.

Department of Agriculture of the Union of South Africa, Division of Entomology, P.O. Box 513, Pretoria.

The Director, The Transvaal Museum, P.O. Box 413, Pretoria, South Africa.

The Honorary Secretary, Entomological Society of Southern Africa, P.O. Box 103, Pretoria.

Algérie:

Société d'Histoire Naturelle de l'Afrique du Nord, Faculté des Sciences d'Alger, Alger.

Allemagne:

Deutsche Entomologische Gesellschaft, 43, Invalidenstrasse, Berlin (IV).

Senckenbergischen Naturforschenden Gesellschaft, Bibliothek, Viktoria Allee 9, Frankfurt A/M.

Bücherei des Zoologischen Museums, 43, Invalidenstrasse, Berlin N 4.

Gesellschaft für Vorratsschutz E.V. (Mitteilungen der), 31, Zimmermannstrasse, Berlin-Steglitz.

Bücherei der Biologischen Reichsanstalt für Land- und Forstwirtschaft. 19, Königin-Luise-Str., Berlin-Dahlem.

Deutsches Entomologisches Institut der Kaiser Wilhelm Gesellschaft (Arbeiten über morphologische und taxonomische Entomologie, Arbeiten über physiologische und angewandte Entomologie), 20, Gossler Strasse, Berlin-Dahlem.

Deutsche Kolonial und Uebersee-Museum, Bahnhofsplatz, Brême.

Administration-Kanzlei des Naturhistorischen Museums, Burgring 7, Vienne (I).

Zoologisch-Botanische Gesellschaft, 2, Mechelgasse, Vienne (III).

Koleopterologische Rundschau, c/o Zoologisch-Botanische Gesellschaft, 2, Mechelgasse, Vienne (III).

Naturhistorischer Verein der Rheinlande und Westfalens (Entomologische Blätter, Decheniana), 4, Maarflach, Bonn.

Münchner Entomologischen Gesellschaft E.V. (Mitteilungen der), c/o Dr. W. Forster, 51, Neuhauser Strasse (Zoolog. Staatssamlg.), Munich (2).

Angleterre :

The Imperial Institute of Entomology, Review of Applied Entomology, 41, Queen's Gate, London S.W. 7.

Zoological Museum (Novitates Zoologicæ), Tring Park, Tring, Herts.

The Apis Club (The Bee World), The Way's End, Foxton, Royston, Herts.

Cambridge Philosophical Society, New Museums, Free School Lane, Cambridge.

The Librarian, The Zoological Society of London, Zoological Gardens, Regent's Park, London, N.W.8.

The Librarian, Department of Entomology, University Museum, Oxford.

Argentine :

Instituto Biologico de la Sociedad Rural Argentina, Buenos Aires.

Sociedad Cientifica Argentina, 1145, Calle Santa Fé, Buenos Aires.

Sociedad Entomologica Argentina, 665, Calle San Martin, Buenos Aires.

Museo Nacional de Historia Natural « Bernadino Rivadavia », Casilla de Correo N° 470, Buenos Aires.

Ministerio de Agricultura (Boletin del Ministerio de Agricultura de la Nacion), Bibliotheca, 974, Paseo Colon, Buenos Aires.

Australie :

The Australian Museum (Records of the Australian Museum), Sydney, N.S.W.

The Entomologist's Office, Department of Agriculture, Sydney, N.S.W.

The Public Library, Museum, and Art Gallery of South Australia, Box 386 A, G.P.O., Adelaide, South Australia.

The Library of the Division of Economic Entomology, P.O. Box No. 109, Canberra City, F.C.T.

The Linnean Society of New South Wales, Science House, Gloucester and Essex Streets, Sydney, N.S.W.

Belgique:

Société Entomologique de Belgique, Musée Royal d'Histoire Naturelle de Belgique, 31, Rue Vautier, Ixelles-Bruxelles.

Société Scientifique de Bruxelles, Secrétariat, 11, Rue des Récollets, Louvain.

Monsieur A. Moureau, Secrétaire du Bulletin de l'Institut Agronomique et des Stations de Recherches de Gembloux, Institut Agronomique de l'Etat, Gembloux.

Lambillionea, Revue Mensuelle de l'Union des Entomologistes Belges (M. F. Derenne), 123, Avenue de la Couronne, Ixelles (Bruxelles).

Annales du Musée du Congo Belge, Tervueren.

Association des Ingénieurs sortis de l'Institut Agronomique de l'Etat, à Gembloux, 35, Avenue des Volontaires, Anderghem-Bruxelles.

Brésil:

Museu National do Rio de Janeiro, Rio de Janeiro.

Instituto Biologico, Bibliotheca, Caixa Postal 2821, São Paulo.

Instituto Oswaldo Cruz, Caixa de Correio 926, Rio de Janeiro.

Arquivos do Serviço Florestal, 1008, Jardim Botânico, Rio de Janeiro.

Academia Brasileira de Sciencias (Annaes da Academia Brasileira de Sciencias), Caixa Postal 229, Rio de Janeiro.

Bulgarie:

Institutions Royales d'Histoire Naturelle, Musée Royal d'Histoire Naturelle, Palais Royal, Sofia.

Société Entomologique de Bulgarie, Musée Royal d'Histoire Naturelle, Palais Royal, Sofia.

Société Bulgare des Sciences Naturelles, Musée Royal d'Histoire Naturelle, Palais Royal, Sofia.

Canada :

Entomological Society of Ontario (The Canadian Entomologist & Reports), Guelph, Ontario.

Bibliothèque du Ministère Fédéral de l'Agriculture, Edifice de la Confédération, Ottawa.

Department of Agriculture, Entomological Branch, Ottawa.

Nova Scotian Institute of Science, Halifax.

Chine :

The Lingnan Science Journal, Lingnan University, Canton.

Bulletin of the Biological Department, Science College, National Sun Yat-Sen University, Canton.

Bureau of Entomology of the Chekiang Province, West Lake, Hangchow.

Chypre :

The Cyprus Agricultural Journal (The Office of the Governement Entomologist), Nicosia.

Colombie (République de), Amérique du Sud :

Revista Facultad Nacional de Agronomia, Biblioteca Facultad Nacional de Agronomia, Universitad Nacional, Medellin.

Cuba :

Sociedad Cubana de Historia Natural « Felipe Poey » (Memorias), c/o Dr. Carlos Guillermo Agnayo, 25 N° 254, Vedado, La Havane.

Danemark :

Entomologisk Forening, Zoologisk Museum, Krystalgade, Copenhague.

Egypte :

Bibliothèque du Cabinet de S.M. le Roi, Palais d'Abdine, au Caire.

Bibliothèque privée de S.M. le Roi, Palais d'Abdine, au Caire.

Ministère de l'Agriculture, Bibliothèque de la Section d'Entomologie, Dokki (Ghizeh), près le Caire.

Société Royale d'Agriculture, Bibliothèque de la Section Technique, Boîte Postale N° 63, au Caire.

Union des Agriculteurs d'Egypte, 25, Rue Cheikh Abou El Sebaa, au Caire.

The Bee Kingdom, 60, Rue Menasce, Alexandrie.

Al-Fellaha, Boîte Postale N° 2047, au Caire.

Société Royale de Géographie d'Egypte, 45, Rue Cheikh Youssef, au Caire.

Bibliothèque du Ministère de l'Instruction Publique, Rue El Falaki, au Caire.

The Journal of the Egyptian Medical Association, Kasr El Aini Post Office, au Caire.

Société Fouad I^er^ d'Economie Politique, de Statistique et de Législation, Boîte Postale N° 732, au Caire.

Institut d'Egypte, Rue Sultan Hussein (ex Rue El Cheikh Rihan), au Caire.

Bibliothèque Egyptienne, Midan Bab El Khalq, au Caire.

Bibliothèque du Musée Agricole Fouad I^er^, Dokki (Ghizeh), près le Caire.

Bibliothèque de la Faculté de Médecine, Université Fouad I^er^, Rue Kasr El Aini, au Caire.

Bibliothèque de la Faculté des Sciences, Université Fouad I^er^, Abbassieh, au Caire.

Equateur (République de l'), Amérique du Sud:

Director General de Agricultura (Revista del Departamento de Agricultura), Quito.

Boletin de la Seccion Agricola del Banco Hipotecario del Ecuador, Apartado 685, Quito.

Espagne:

Instituto Nacional de 2ª Ensenanza de Valencia, Laboratorio de Hidrobiologia Espanola, Valencia.

Junta para ampliacion de Estudios e Investigaciones Cientificas, 4, Duque de Medinaceli, Madrid.

Junta de Ciencies Naturales de Barcelona, Museo Municipal, Barcelona.

Real Academia de Ciencias y Artes de Barcelona, 9, Rambla de los Estudios, Barcelona.

Sociedad Espanola de Historia Natural, Museo Nacional de Ciencias Naturales, Hipodromo, Madrid (VI).

Estacion de Patologia Vegetal, Instituto Nacional Agronomico, La Monclea, Madrid (VIII).

Etats-Unis:

The Research Library, Buffalo Socicety of Natural Sciences, Buffalo Museum of Science, Humboldt Park, Buffalo, New-York.

University of Illinois Library, Exchange Division, Urbana, Illinois.

Library of the American Museum of Natural History, Central Park, West at 79th Street, New-York City.

Pacific Coast Entomological Society (The Pan-Pacific Entomologist), California Academy of Sciences, Golden Gate Park, San Francisco, California.

Academy of Natural Sciences, Entomological Section, Lagon Square, Philadelphia.

Experiment Station of the Hawaiian Sugar Planters' Association, P.O. Box 411, Honolulu, T.H., Hawai.

Hawaiian Entomological Society, c/o Experiment Station of the Hawaiian Sugar Planters' Association, P.O. Box 411, Honolulu, T.H., Hawai.

Carnegie Museum, Department of the Carnegie Institute, Pittsburgh, Pennsylvania.

American Entomological Society, Academy of Natural Sciences, Logan Square, Philadelphia, Pa.

United States Department of Agriculture, Washington, D.C.

General Library, University of Michigan, Ann Arbor, Michigan.

United States National Museum, Smithsonian Institution, Washington, D.C.

Smithsonian Institution Library, Washington, D.C.

Library of the New-York State College of Agriculture and Agricultural Experiment Station, Cornell University, Ithaca, New-York.

New-York Academy of Sciences, New-York.

Pennsylvania State Health Department, Pennsylvania.

University of California Library, Berkeley, California.

University of California, Citrus Experimental Station Library, Riverside, California.

Wisconsin Academy of Sciences, Arts, and Letters, Madison, Wisconsin.

Library, Minnesota Agricultural Experiment Station, University Farm, Saint Paul, Minnesota.

Museum of Comparative Zoology, Harward College, Cambridge, Mass.

The Philippine Agriculturist, Library, College of Agriculture, Agricultural College, Laguna, Philippine Islands.

Editorial Office, The American Midland Naturalist, University of Notre Dame, Notre Dame, Indiana.

Marine Biological Laboratory, Library, Woods Hole, Mass.

Finlande:

Societas Entomologica Helsingforsiensis, Helsinki.

Societas pro Fauna et Flora Fennica, Kaserngatan 24, Helsinki.

Societas Zoologica-Botanica Fennica Vanamo, Säätytalo, Snellmanstr. 9-11, Helsinki.

Société Entomologique de Finlande (Annales Entomologici Fennici), Institut de Zoologie Agricole et Forestière de l'Université, Snellmaninkatu 5, Helsinki.

France:

L'Echange, Revue Linnéenne, Digoin (Saône et Loire).

Revue française d'Entomologie, Museum National d'Histoire Naturelle (Entomologie), 45 bis, Rue de Buffon, Paris (V^e).

Revue Scientifique du Bourbonnais et du Centre de la France, 22, Avenue Meunier, Moulins (Allier).

Société d'Etudes des Sciences Naturelles de Nîmes, 6, Quai de la Fontaine, Nîmes (Gard).

Société de Pathologie Végétale et d'Entomologie Agricole de France, Laboratoire de Pathologie Végétale, Institut National Agronomique, 16, Rue Claude Bernard, Paris (V^e).

Société Linnéenne de Bordeaux, Athénée, 53, Rue Des Trois Conils, Bordeaux.

Société Linéenne de Lyon, 33, Rue Bossuet (Imm. Municipal), Lyon.

Société des Sciences Naturelles de l'Ouest de la France, Nantes (Loire Inférieure).

Association des Naturalistes de Levallois-Perret, 153, Rue du Président Wilson (Domaine de la Planchette), Levallois-Perret (Seine).

Société Linnéenne du Nord de la France, 81, Rue Lemerchier (M. Pauchet), Amiens.

Société Géologique de Normandie et des Amis du Museum du Havre, Hôtel des Société Savantes, 56, Rue Anatole France, Le Havre (Seine Inférieure).

Société d'Histoire Naturelle de Toulouse, Bibliothèque Universitaire de la Faculté de Médecine, Allée Saint-Michel, Toulouse.

Société Entomologique de France, Institut National Agronomique, 16, Rue Claude Bernard, Paris (V^e).

Société d'Etudes Scientifiques de l'Aude, Carcassone (Aude).

Annales des Epiphyties et de Phytogénétique, Centre National des Recherches agronomiques, à Versailles, France.

Museum National d'Histoire Naturelle, Bibliothèque, 8, Rue de Buffon, Paris (V^e).

Société de Zoologie Agricole (Revue de Zoologie Agricole et Appliquée), Faculté des Sciences, Institut de Zoologie, 40, Rue Lamartine, Talence (Gironde).

Grèce:

Institut Phytopathologique Benaki, Kiphissia (près Athènes).

Bibliothèque de l'Institut et Musée Zoologique de l'Université, Athènes.

Hollande:

Bibliotheek van der Nederlandsche Entomologische Vereeniging, p/a Bibliotheek van het Kolonial Instituut, 62, Mauritskade, Amsterdam.

Landbouwhoegeschool Laboratorium voor Entomologie, Berg 37, Wageningen.

Hongrie:

Museum National Hongrois (Annales Historico-Naturales), 13, Barossutca, Budapest VIII.

Indes:

Zoological Survey of India (Records of the Indian Museum), Indian Museum, Calcutta.

Madras Governement Museum, Connemara Public Library, Egmore, Madras.

Office of the Director, Imperial Agricultural Research Institute, New Delhi.

Indes Néerlandaises:

Bibliotheek van het Departement van Economische Zaken, Groote Weg 20, Buitenzorg, Java.

Italie:

Museo Civico di Storia Naturale « Giacomo Doria », 9, Via Brigata Liguria, Genova (102).

Rivista di Biologia Coloniale, 326, Viale Regina Margherita (Policlinico), Roma.

Museo Civico di Storia Naturale di Trieste (Atti del), 4, Piazza Hortis, Trieste (10).

Società dei Naturalisti in Napoli, Reale Università, Via Mezzocannone, Napoli.

Società Entomologica Italiana, Museo Civico di Storia Naturale, 9, Via Brigata Liguria, Genova (102).

Società Adriatica di Scienze Naturali, 7, Via dell'Annunziata, Trieste.

La Reale Stazione di Entomologia Agraria (Redia), 19, Via Romana, Firenze (32).

La Reale Stazione Sperimentale di Gelsicoltura e Bachicoltura di Ascoli Piceno.

Istituto Zoologico della Reale Università di Napoli (Biblioteca del), Via Mezzocannone, Napoli.

Laboratorio di Zoologia Generale e Agraria del Reale Istituto Superiore Agrario in Portici, Portici (Napoli).

Reale Laboratorio di Entomologia Agraria di Portici (Bolletino del), Portici (Napoli).

Bibliothèque de l'Institut International d'Agriculture (Moniteur International de la Protection des Plantes), Villa Umberto I, Rome (110).

Società italiana di Scienze Naturali, Palazzo del Museo Civico di Storia Naturale, Corso Venezia, Milano.

Istituto di Zoologia della Reale Università di Genova (Bollettino dei Musei di Zoologia e di Anatomia comparata), 5, Via Balbi, Genova.

Società dei Naturalisti e Matematici di Modena, presso la Reale Università, Modena.

Istituto di Entomologia della Reale Università, 6, Via Filippo Re. Bologna (125).

Reale Accademia di Scienze, Lettere ed Arti in Padova, 15, Via Accademia, Padova (Veneto).

Museo di Storia Naturale della Venezia Tridentina (« Memorie del Museo di Storia Naturale della Venezia Tridentina » e « Studi Trentini di Scienze Naturali »), Casella Postale 95, Trento.

Reale Istituto Agronomico per l'Africa Italiana (L'Agricoltura Coloniale), Ministero dell'Africa Italiana, 9, Viale Principe Umberto, Firenze.

Istituto di Entomologia Agraria e Bachicoltura della Reale Università (Bolletino di Zoologia Agraria e Bachicoltura), 2, Via Celoria, Milano (133).

Società Veneziana di Storia Naturale (presso Sig. Antonio Giordani Soika), S. Marco 254, Venezia.

Japon:

Saghalien Central Experiment Station, Konuma, Saghalien.

The Ohara Institute for Agricultural Research, Library, Kurashiki, Okayama-Ken.

Imperial Agricultural Experiment Station (Journal of the), Nishigahara, Tokyo.

Departement of Agriculture, Government Research Institute, Taihoku, Formosa.

The Kansai Entomological Society, c/o N. Tosawa, Shibakawa-Noen, Kotoen, Mukogun, Hyogo-ken.

« Mushii », Entomological Laboratory, Department of Agriculture, Kyushu Imperial University, Fukuoka.

Takeuchi Entomological Laboratory (Tenthredo, Acta Entomologica), Shinomyia Yamashina, Kyoto.

Kenya :

East Africa and Uganda Natural History Society, Coryndon Memorial Museum, P.O.Box 658, Nairobi, Kenya Colony, British East Africa.

Libye :

Museo Libico di Storia Naturale, Piazza Santa Maria degli Angeli, Tripoli d'Africa.

Maroc :

Société des Sciences Naturelles du Maroc, Institut Scientifique Chérifien, Avenue Biarnay, Rabat.

Défense des Végétaux, Service de l'Agriculture et de la Colonisation, Direction des Affaires Economiques, Rabat.

Mexique :

Junta Nacional Directora de la Campana contra la Langosta (Junosta), Biblioteca, Departamento Directivo, Veracruz.

Biblioteca del Instituto Biotecnico, Calzada Mexico-Tacuba N° 295, Col. Anahuac, D.F.

Biblioteca del Instituto de Biologia, Chapultepec (Casa del Lago), Mexico, D.F.

Anales de la Escuela Nacional de Ciencias Biologicas, Apartado Postal 7016, Mexico, D.F.

Norvège :

Tromso Museum Library, Tromso.

Panama (République de) :

Departamento Seccional de Agricultura (Boletin Agricola), Panama.

Pologne:

Musée Zoologique Polonais, Wilcza 64, Varsovie (1).

Société Polonaise des Entomologistes, Rutowskiego 18, Lwow.

Institut de Recherches des Forêts de l'Etat, Wawelska 54, Varsovie.

Portugal:

Société Portugaise des Sciences Naturelles, Instituto de Fisiologia, Faculdade de Medicina, Lisbonne.

Museum Zoologique de l'Université de Coimbra, Largo Marquês de Plombal, Coimbra.

Associçao da Filosofia Natural, na Faculdade de Ciencias, Porto.

Roumanie:

Société Transylvanienne des Sciences Naturelles (Siebenbürgischer Verein für Naturwissenschaften), Hermannstadt, Sibiu.

Academia Romana, Bibliothèque, Calea Victoriei, 125, Bucarest.

Russie (U.S.S.R.):

Société Entomologique de Russie (Revue Russe d'Entomologie et Horae), Musée Zoologique de l'Académie des Sciences, Léningrad.

Bibliothèque de l'Académie des Sciences de l'Ukraine, 58a, Rue Korolenko, Kiew (Ukraine).

Société des Naturalistes de Kiew, 37-10, Rue Korolenko, Kiew (Ukraine).

Institut des Recherches Biologiques de l'Université de Perm, Perm II, Zaimka.

Institute for Plant Protection, Bureau of Applied Entomology and Zoology, Library, 10, Elagin Ostrov, Léningrad.

Rédaction du Journal « Plant Protection », 7, Rue Tschaikovsky, Leningrad.

Institute for controlling Pests and Diseases, Library, 7, Tschaikovsky Str., Leningrad 28.

Siam:

Department of Agriculture and Fisheries, Entomology Section, Bangkok.

Suède:

K. Swenska Vetenskapsakademien i Stockholm, Stockholm 50.

Entomologiska Foreningen, Brottninggatten 94, Stockholm.

Göteborgs Kungl. Vetenskaps-och Vitterhets Samhälles, Göteborg.

Statens Växtskyddsanstalt, Stockholm 19.

Bibliothèque de l'Université de Lund, Lund.

Suisse:

Bibliothèque de la Société Entomologique Suisse, Musée d'Histoire Naturelle, Berne.

Zentralbibliotek, Naturforschenden Gesellschaft, Zurich.

Tcheco-Slovaquie:

Societas Entomologica (Casopis), u Karlova 3, Prague II.

Section Entomologique du Musée National de Prague (Sbornik), Prague II-1700.

Bibliothèque de la Société Zoologique Tchécoslovaque, Institut de Zoologie, Karlov 3, Prague II.

Uruguay (République de l'):

Escuela de Veterinaria del Uruguay (Anales de la Escuela de Veterinaria del Uruguay), Itazaingo 1461, Montévideo.

Sociedad de Biologia de Montevideo, Casilla de Correo 567, Montevideo.

Yougo-Slavie:

Societas Entomologica Jugoslavica (Glasnik), 17, Garasaninovo ulica, Belgrade.

N.B. — Pour changement d'adresse, erreurs ou omissions, s'adresser à Monsieur le Secrétaire Général de la Société Fouad Ier d'Entomologie, Boîte Postale N° 430, au Caire.

PROCES-VERBAUX DES RÉUNIONS

Thé Commémoratif du 28 Janvier 1941

Présidence de Monsieur le Professeur Mahmoud Tewfik Hifnaoui Bey

Allocution du Président :

Mesdames, Messieurs,

Je suis heureux de vous voir réunis ici à l'occasion du 14ème anniversaire de l'inauguration du Siège de la Société par Sa Majesté le Roi Fouad Ier, dont la mémoire est toujours vivante et vénérée parmi nous.

Vous savez tous combien ce grand monarque nous a comblé de bienfaits et l'intérêt qu'Il nous a témoigné durant son glorieux règne.

Notre Siège a été solennellement inauguré le 28 Janvier 1928. Quelques années plus tard, et anticipant les besoins de la Société, Sa Majesté le Roi Fouad Ier en ordonnait l'extension. Ce qui nous semblait alors l'extrême limite de nos besoins s'avère aujourd'hui insuffisant, nous donnant ainsi une idée de la clairvoyance de notre illustre bienfaiteur.

Je veux espérer que la réunion d'aujourd'hui sera le début d'une plus grande et plus efficace coopération entre tous les membres de la Société et qu'elle servira à resserrer les rapports cordiaux qui vous ont toujours unis.

Séance du 26 Février 1941

Présidence de S.E. Fouad Abaza Pacha

Echange de Publications :

Le Conseil approuve l'échange des publications de la Société avec les Annales de l'Académie Brésilienne des Sciences de Rio de Janeiro.

Admission de Membres :

Sur la proposition de Messieurs le Professeur Docteur Hamed Seleem Soliman et A. Alfieri, Messieurs Mohamed Abou El Fath, Mahmoud Mohamed Ibrahim Zeid, Saleh Kamel El Sawaf et Abdel Latif Amin El Dib sont admis à faire partie de la Société en qualité de Membres Titulaires.

Séance du 23 Avril 1941

Présidence de Monsieur le Professeur H. C. Efflatoun Bey

Don à la Bibliothèque :

Monsieur le Docteur Ahmed Salem Hassan adresse un exemplaire de son ouvrage sur « *Les insectes d'importance économique en Egypte* », publié en langue arabe, en 1939, au Caire.

Le Conseil remercie.

Admission d'un Membre :

Sur la proposition de Messieurs Mohamed El Zoheiry et Antoine Cassab, Monsieur Aly Fahmy, de la Section d'Entomologie du Ministère de l'Agriculture, est admis à faire partie de la Société en qualité de Membre Titulaire.

Bureau et Comité Scientifique :

Les élections relatives à la constitution du Bureau du Conseil et du Comité Scientifique pour l'exercice 1941 donnent les résultats qui suivent :

Sont élus : Monsieur le Professeur H. C. Efflatoun Bey et Monsieur Mohamed Soliman El Zoheiry, *Vice-Présidents ;* Monsieur Anastase Alfieri, *Secrétaire Général ;* Monsieur Richard Wilkinson, *Trésorier.*

Sont élus membres du Comité Scientifique : Messieurs le Professeur H. C. Efflatoun Bey, le Professeur Docteur Kamel Mansour, le Professeur Docteur Hamed Seleem Soliman, le Docteur Saadallah Mohamed Madwar, le Docteur Mohamed Shafik, Mohamed Soliman El Zoheiry et Anastase Alfieri.

Séance du 29 Octobre 1941

Présidence de S.E. Fouad Abaza Pacha

Nécrologie :

Le Secrétaire Général a le regret de faire part du décès de Ragheb Abdel Malek, qui s'est éteint prématurément le 26 Avril écoulé. Cet estimé collègue était membre de notre Société depuis de longues années. Il occupait, avant sa disparition, les fonctions de chef de la section d'entomologie du Musée agricole Fouad Ier.

Donations:

Les donations qui suivent ont été reçues par la Société:

L.Eg. 50 de la Société Royale d'Agriculture.

L.Eg. 25 de l'Imperial Chemical Industries (Egypte) S.A.

L.Eg. 25 de la Société Générale des Sucreries et de la Raffinerie d'Egypte.

L.Eg. 15 de la Société Financière et Industrielle d'Egypte.

Le Conseil remercie Son Altesse le Prince Omar Toussoun, Président, et Son Excellence Fouad Abaza Pacha, Directeur Général de la Société Royale d'Agriculture, Monsieur Stener Vogt. Directeur de l'Imperial Chemical Industries, Monsieur H. Naus, Directeur Général de la Société Générale des Sucreries et de la Raffinerie d'Egypte, Monsieur Eshak Mohamed, Directeur Général, ainsi que Monsieur le Docteur Mohamed Shafik, Directeur Technique de la Société Financière et Industrielle d'Egypte pour leur généreuse contribution au développement de notre Société.

Contribution aux collections d'ornithologie:

Monsieur le Professeur H. C. Efflatoun Bey a rapporté du Sinaï trois spécimens vivants d'*Alectoris graeca sinaica* Bon. ou « perdrix choukar ». Cette forme n'était pas représentée dans nos collections et nous sommes particulièrement heureux de l'avoir reçue de notre collègue H. C. Efflatoun Bey.

Le Conseil remercie le généreux donateur.

Assemblée Générale Ordinaire du 26 Mars 1941

Présidence de Monsieur le Professeur H. C. Efflatoun Bey,
Vice-Président

Rapport du Secrétaire Général (exercice 1940) :

Messieurs,

En présence de la situation difficile actuelle, la Société Fouad Ier d'Entomologie a manifesté une fois de plus sa vitalité en ne changeant rien à sa marche régulière.

Rappelons, tout d'abord, la satisfaction que nous a causé le décret royal. du 19 Février 1940, nommant Son Excellence Mahmoud Tewfik Hifnaoui Bey Président de la Société.

Dès son entrée en fonctions, votre nouveau président n'a ménagé aucun effort pour améliorer notre situation financière. A la suite des démarches faites par Son Excellence, nous avons reçu les donations suivantes :

L.Eg. 50 de la Société Royale d'Agriculture,

L.Eg. 25 de l'Imperial Chemical Industries (Egypt), S.A.,

L.Eg. 25 de la Société Générale des Sucreries et de la Raffinerie d'Egypte.

Nous renouvelons ici nos sentiments de vive gratitude à Son Altesse le Prince Omar Toussoun, président de la Société Royale d'Agriculture, à son directeur général Son Excellence Fouad Abaza Pacha, à Monsieur Stener Vogt, directeur de l'Imperial Chemical Industries, et à Monsieur H. Naus, directeur de la Société Générale des Sucreries et de la Raffinerie d'Egypte, et les remercions pour leur généreuse contribution.

Votre Conseil a institué un comité chargé d'élaborer un programme susceptible de développer les rapports existant entre les membres de la Société. Les recommandations suivantes, présentées par ce Comité, ont été approuvées par votre Conseil :

1°) Les travaux destinés à être publiés dans les Bulletins ou dans les Mémoires de la Société constituent des sujets trop scientifiques pour en faire l'objet de réunions publiques.

2°) De limiter ces réunions à des conférences d'intérêt général, à des causeries ou échanges de vues entre membres sur les problèmes entomologiques qui pourraient les intéresser.

3°) Qu'il soit fait, sous la direction de personnes expérimentées, des excursions entomologiques aux époques favorables.

4°) Qu'un thé annuel soit donné le 28 Janvier de chaque année pour commémorer l'inauguration du Siège de la Société par feu le Roi Fouad Ier.

Nous faisons donc appel à votre concours et à vos initiatives afin que ce projet soit réalisé et poursuivi dans l'intérêt général.

Aux nombreux techniciens et étudiants des différentes facultés qui ont régulièrement fréquenté nos salles, il y a lieu d'ajouter les visites quotidiennes du public et celles des établissements scolaires.

Au début de l'année, vous avez reçu le vingt-troisième volume de notre Bulletin, composé de plus de 400 pages, contenant 24 travaux originaux illustrés de très nombreuses gravures et de 3 planches en couleurs.

Le nombre de nos membres et adhérents de toutes catégories est stationnaire.

Quelques dons ont augmenté le chiffre des ouvrages reçus par voie d'échange et destinés à la Bibliothèque. Le dernier enregistré porte le numéro 13316.

Nous avons reçu du Ministère de l'Agriculture un chèque de L.Eg. 397 à titre de subvention pour l'année 1940. Que Son Excellence le Ministre de l'Agriculture veuille bien accepter nos plus vifs remerciements.

Le contrat de votre conservateur a été renouvelé pour une nouvelle période de trois ans.

Votre trésorier a établi le Bilan des Comptes de l'Exercice dûment approuvé par vos Censeurs.

Aux termes de l'article 13 des statuts le Conseil est annuellement renouvelé par tiers. Les membres sortants cette année sont les suivants : Messieurs le Professeur H. C. Efflatoun Bey, le Professeur Docteur Kamel Mansour, le Docteur Saadallah Mohamed Madwar, A. Alfieri. Ils sont rééligibles.

Vous aurez également a désigner le remplaçant de Monsieur le Professeur Docteur H. Priesner et à élire deux Censeurs.

En terminant, nous dédions nos respectueuses pensées à notre Auguste Souverain, Sa Majesté le Roi Farouk Ier, et Lui exprimons nos sentiments de profonde dévotion et nos vœux les plus fervents.

Signé : A. Alfieri

Rapport du Trésorier :

Situation au 31 Décembre 1940

Doit **Avoir**

	L.E.	MM.		L.E.	MM.
Compte Bâtiment (pour mémoire)	1	000	Compte Réserve Générale	15519	415
» Mobilier »	1	000	» Subvention du Gouvernement.....	397	595
» Bibliothèque »	1	000	» Donations	100	000
» Collections »	1	000	» Coupons	704	667
» Laboratoire »	1	000	» Intérêts.....	25	822
» Portefeuille	13535	913	» Cotisations	61	985
» National Bank of Egypt.	1939	666	» Diplômes	1	200
» Cie du Gaz	4	629			
» Appointements.....	819	000			
» Publications.....	346	607			
» Frais Généraux et Entretien	117	967			
» Impôts et Assurances..	41	902			
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Inventaire

Actif **Passif**

Bâtiment (pour mémoire)	1	000	Réserve Générale.....	15485	208
Mobilier »	1	000			
Bibliothèque »	1	000			
Collections »	1	000			
Laboratoire »	1	000			
Portefeuille	13535	913			
National Bank of Egypt.....	1939	666			
Cie du Gaz.....	4	629			
	15485	208		15485	208

Le Portefeuille Titres en dépôt à la National Bank of Egypt se décompose comme suit :

145 Obligations Héliopolis 5 %.
9020 £ Dette Unifiée Egyptienne 4 %.
6700 £ Dette Privilégiée Egyptienne 3 ½ %.

Signé : R. WILKINSON

Rapport des Censeurs :

En exécution du mandat que vous avez bien voulu nous confier, nous avons l'honneur de porter à votre connaissance que nous avons vérifié les Comptes de la Société Fouad I^er^ d'Entomologie pour l année finissant le 31 Décembre 1940 avec les régistres et documents y relatifs.

Nous certifions que le Bilan reflète d'une façon exacte et sincère la situation de la Société telle qu'elle ressort des registres et des explications qui nous ont été données.

Signé : Dr. A. Azadian et E. Kaourk

Prévisions Budgétaires pour l'année 1941 :

Recettes			**Dépenses**		
	L.E.	MM.		L.E.	MM.
Subvention du Gouvernement Egyptien	400	000	Publications	200	000
Donations	100	000	Appointements	819	000
Coupons	704	000	Frais Généraux	150	000
Cotisations	60	000	Impôts	36	000
Intérêts	25	000	Assurances	26	000
Vente Publications	5	000	Abonnements Bibliothèque	5	000
			Entretien	15	000
			Imprévus	43	000
	1294	000		1294	000

Signé : R. Wilkinson

Décisions :

1° L'Assemblée Générale Ordinaire approuve les Rapports du Secrétaire Général, du Trésorier et des Censeurs et donne décharge au Conseil de sa gestion pour l'exercice 1940.

2° Sur la proposition de Messieurs le Docteur Hamed Seleem Soliman et Hugh Miller (délégué de l'Imperial Chemical Industries), l'Assemblée adopte une motion de remerciements en faveur des Membres du Conseil, du Secrétaire Général et du Trésorier, pour leur excellente gestion de la Société durant l'exercice écoulé.

Elections :

Messieurs le Professeur H. C. Efflatoun Bey, Professeur Docteur Kamel Mansour et Anastase Alfieri, membres du Conseil sortants, sont réélus.

Monsieur Edgard Chakour est élu en remplacement de Monsieur le Professeur H. Priesner.

Messieurs le Docteur A. Azadian et E. Kaourk sont réélus aux fonctions de Censeurs des Comptes de la Société.

Studies in the structure of *Microbracon hebetor* Say

[Hymenoptera: Braconidae]

(with 6 Text-Figures and Plates I-XVII)

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I. INTRODUCTION

This work has been attempted with a view of elucidating some of the important points in the morphology of a Braconid-Type. It is a continuation of a previous work on the biology of the same insect published by the author in this Bulletin (Vol. XXIV, 1940, pp. 215-247).

II. TECHNIQUE

In studying the larval tracheal system Berlese solution and glycerine whole mounts were invaluable.

In fixing the adult, it was found necessary to decapitate it or to cut the body in two at the propodium. Fixing under vacuum gave more satisfactory results. Freshly prepared carnoy, for two hours and a half, at room tempe-

rature, and Bouin's fluid at 60° C. for one hour gave good results. Clearing was best carried out in cedar wood oil, and then the material was slowly graded from cedar wood oil into paraffin wax of 60° C. melting point. The celloidin and wax embedding method was tried; but it was found more satisfactory to fix just when the insect emerged before the chitin hardened and to embed only in wax. The following stains were satisfactorily used : (1) Delafield's haematoxylon and eosin, (2) Mann's staining fluid, (3) Heidenhain's iron alum haematoxylon, (4) Mayer's haemalum, (5) Mallory's phosphomolybdic triple stain, and (6) Aniline blue in picric.

All figures, unless otherwise stated, are camera lucida drawings.

III. The EGG

The egg (Plate I, fig. 2) is tiny, pearly white in colour, opalescent, and sausage shaped , with the two ends rounded but one slightly more acute than the other. One side is slightly convex, the other somewhat concave; there is no stalk, no pattern whatever on the outer surface of the chorion. The average length of the egg is 0.584 mm. and the average diameter is 0.152 mm. When development starts, the egg turns transparent except the area occupied by the embryo, this area appears tranlucent.

IV. The LARVA

There are three ecdysis during the larval life history. The first takes place quite early when the larva is about 0.650 mm. in length, the second soon after, and the third when it is about 1.060 mm.. Thus there are four larval instars.

First instar

When first hatched, the larva is a tiny creature about 0.530 mm. in length, 0.120 mm. in diameter, snowy white in colour and nearly transparent, with the yellowish alimentary canal running through its length. The segmentation of the body is sharply defined. There is a head and a trunk of thirteen segments, the body tapering posteriorly to a point. The head is comparatively big, nearly one-fifth of the whole length of the insect (Plate I, fig. 3) ; it bears two short dorsal antennae, and has the mouth-parts on the ventral side.

Second instar

The second instar, generally, does not differ very much from the first instar except in size and in the number of the mandibular teeth.

Third instar

At the end of the second stage the colour of the larva begins to show itself. In the third stage the larva is no longer transparent, but is generally pearly white. The colour changes according to the colour of the particular region of the host on which the parasite larva has been feeding. A larva which draws its food from, or near, the gonads of an *Ephestia kühniella* Z. caterpillar, is pink or reddish because the gonads of the *Ephestia kühniella* Z. (male) are dark red. Sometimes the parasitic larva is greenish, after a green tinge in the colour of the host.

This instar is cylindrical in shape, tapering towards both ends. The proportion of the head compared to the trunk is very much smaller than what it was during the first stage. The head is no longer prominent as it used to be in the first and second instars. The body is clothed with small spines, which, together with the integumental secretion and protuberances, probably helps in keeping the parasite adhering to its host. Rows of sensory hairs which are longer than the spines are also found segmentally arranged over the whole body. The segmentation is no longer sharply defined as it was in the previous stage. White urate cells can be distinctly seen through the integument. The mid-gut now has grown to occupy most of the body cavity.

Fourth instar

The colour of this instar (Plate I, fig. 4) remains the same as that of the previous one. The form of the body becomes arched, with marked protuberances. The head becomes slightly telescoped into the prothorax and the spines and sensory hairs become more prominent. The mid-gut now fills almost all the body cavity, the salivary glands are well developed, and the tracheal system more branched than was the case in the previous stages. The spiracles can, with care, be detected at the bottom of tiny dimples. At the end of this stage the larva is about 3.0 to 3.2 mm.

The mouth, a transverse slit on the ventral side of the head (Plate II, fig. 10), has its full complement of mouth-parts, and is surrounded and supported by a well developed chitinous ring. On each side this ring is held by two chitinous branches, one of which starts at the basis of the mandible, the other between the maxilla and the labium. These two branches run nearly parallel for a short distance, and then meet to form a powerful strut which runs in the lateral side of the head (Plate II, fig. 10).

The labium overhanging the mouth is short and broad with six sensory hairs near its anterior margin and two towards its posterior. The mandibles lie across the mouth with their bases attached to the chitinous ring. They

have a large tooth and a comb of several dentines and they are best seen in a specimen treated with caustic potash. The maxilla is an inconspicuous protuberance with two sensory hairs at the base and a papilla towards its tip. Each maxilla lies on one side of the mouth, between the two incomplete axes of the chitinous ring with its base fixed on the ring itself. Its tip is free and borders one corner of the mouth. The labium is bounded by a crescent-shaped chitinous support, its tip is irregular and forms the ventral border of the mouth. Near its posterior end there are four sensory hairs, and at about its middle there are two papillae exactly similar to those on the maxilla. Anteriorly the labium bears the opening of the salivary glands. It might be mentioned here that the mouth parts differ in different larval instars.

Alimentary canal

The mouth opens into a short funnel-shaped pharynx (Plate II, fig. 13) with the cells of the dorsal wall comparatively high, while those of the ventral wall are normal. It is provided with a prowerful muscular system which enables it to carry out its pumping function. The pharynx leads into the oesophagus which is a short tube opening into the mid-gut by means of a valve (Plate II, fig. 13). Throughout its length the fore-gut (pharynx and oesophagus) is lined with cuticular intima which is continuous with the external cuticle covering the head (Plate II, fig. 13).

The mid-gut or mesenteron is a large pouch which begins in the second thoracic segment and ends in the eighth abdominal. These limits can best be seen in the very early stages of the larva when this pouch is not so dilated with food. In the later stages the mid-gut almost fills the whole of the body (Plate II, fig. 11).

The mid-gut is followed by the hind-gut which is short and dilated anteriorly into a sort of ampulla. It then opens into the anus by a narrow canal, the cells of whose walls are long and narrow (Plate II, fig. 12).

The malpighian tubules are two in number and begin where the mid- and hind-gut meet. They stretch forwards running under and beside the alimentary canal.

The salivary glands are very well developed and run on both sides of the gut through the whole length of the body (Plate II, fig. 11). In fact, they are much longer than the body of the larva and are twisted into several regular convolutions. The two branches on each side unite in the thorax, the duct formed, meeting the corresponding duct of the other side beneath the alimentary canal. This single median duct then opens in the labium, just behind the mouth.

Respiratory system

There are nine spiracles on each side, arranged in a row parallel to the longitudinal axis of the body, and situated in a nearly dorso-lateral position. The first and most anterior pair lies in the posterior part of the prothorax (Plate I, fig. 4; Plate II, fig. 8). The other eight pairs of spiracles lie in the first eight abdominal segments, a pair in each segment. In the metathorax there is a well developed spiracular trunk but the spiracle is closed and the spiracular branch is missing.

All spiracles are of the same size and shape. Each is a minute round aperture, devoid of lips, closing apparatus, and with no external hairs around the opening. The spiracles are connected to the tracheal trunks by short narrow branches, the spiracular branches.

The tracheal system consists of a longitudinal trunk on each side of the body, lying nearly midway between the dorsal and ventral lines. These two trunks are connected anteriorly by a dorsal arch which lies in the front region of the prothorax. Posteriorly, the two trunks are united by a connection situated in the ninth abdominal segment, and which passes ventral to the hind-gut. In front of the anterior dorsal arch each trunk gives off two branches which go to, and ramify in, the head aerating all its parts. The ventral connection of the two trunks which lies in the ninth abdominal segment gives off a ventral branch which ramifies posteriorly (Plate II, figs. 8 and 9).

Each lateral trunk gives off ten simple secondary dorsal branches and ten secondary ventral branches, two of which are simple and eight bifid. The two simple ventral branches lie in the thorax, the eight bifid lie segmentally arranged in the first eight abdominal segments. Each dorsal branch originates in the anterior part of its segment, the ventral having its origin a little further behind in the corresponding segment, except in the case of the most anterior secondaries where the dorsal branch originates behind the ventral. Each of the eight bifid ventrals in the abdominal segments has two branches. One, the anterior, ramifies into many small branches, the other, which is thicker, meets the corresponding opposite branch ventral to the nerve chord. The dorsals are not a thick as the ventrals and form many more finer tracheoles which aerate the whole dorsal and dorso-lateral parts of the body.

The tracheal system does not differ in the different instars of the larva.

V. The COCOON

The cocoon (Fig. 1) is snow-white in colour but exposure to dust causes it to become dirty white. It is about 4 to 5 mm. long and 1 to 1.5 mm. in diameter, and is very strongly but loosely interwoven and difficult to cut.

If it is spun on a smooth surface like glass the side next to the glass is left uncovered. Thus the observer can clearly see the development through the glass. The cocoon is usually formed in a place well away from the remains

Fig. 1. — Cocoons and their position relative to remnant of host. — × 2.

of the host, a number of larvae spinning their cocoons close to each other and covering them with a loose common web of the same material. In many cases, however, the coocons are solitary and in some cases they may be formed in company with others but with the common covering web absent.

VI. The PREPUPA

The time of transformation of the larva into prepupa is well marked by a black mass accumulating at one end of the cocoon just behind the posterior end of the insect (Plate I, fig. 5). This black mass is the faeces and cast skin of the last larval instar. The prepupa is of the same colour as the larva, its length being about 2.4 to 3.0 mm. The head and thoracic segments are well developed, and, for the first time, the waist of the future adult becomes apparent. The eyes also appear at this stage and can be seen through the prepupal skin.

VII. The PUPA

The pupa is 2.78 mm. in length, and emerges with all its organs compactly arranged (Plate I, fig. 6). The skin of the prepupa is cast away and left in the cocoon at the posterior end near the above mentioned black refuse. The head is well developed and carries the three ocelli, the two compound eyes, the antennae, and the mouth parts.

The antennae are kept straight, ventral to face and body, in their cuticular cases. In the female they do not extend behind the waist. In the male they reach half-way along the abdomen, their joints are clearly marked.

The mouth parts are complete and arranged round the mouth on the ventral side. The maxillary palpi are comparatively long and five-segmented, the labial palpi being short and three-segmented.

Each of the wings is folded on itself in its case and all are folded down to the sides of the pupa. They do not extend further back than the second abdominal segment.

The legs are completely developed and neatly folded ventrally along the sides of the pupa, the hind pair not extending behind the sixth abdominal sternite.

The genital armature in males is completely developed, but not yet scleritised. In the female the stylet and stylet-sheath are partly folded ventrally to the body, their ends together with the sting palpi are curved over.

VIII. The ADULT

General appearance

The adult (Plate I, fig. 7) has an average length of 3.0 to 3.5 mm. and has a wing expanse of about 6 mm. The general colour as seen with the naked eye is dark brown, the ventral side of the abdomen being dirty white The antennae in both sexes as well as the palpi of the female's ovipositor are much darker, whilst the compound eyes and ocelli are black. Under the binocular microscope, the ground colour of the insect is testaceous with very dark patches on certain sclerites. The body is clothed with scattered yellowish hairs, and the wings are dark and iridescent. The legs are testaceous with the middle and hind coxae, the basal joint of the trocanter and the basis of the femur dark brown.

Head and appendages (1)

Head capsule

The head is free from the thorax and is extremely mobile. Mouth is ventral. Viewed from its frontal and posterior aspects, the head is subtriangular in outline (Plate III, figs. 14 and 15), at the dorsal basis of the «triangle» the three ocelli are situated, one median, and two lateral. At the sides of the triangle are the two large oval compound eyes. Ventral to the occipital foramen, the head capsule is excavated into a concavity in which the proximal ends of the mouth parts are lodged (Plate III, fig. 15). Viewed from its lateral aspect, the head is oblong, with a concavity ventral to the clypeus (Plate XII, fig. 88).

The head, like the rest of the body, is covered with testaceous «hairs».

In this specialised head capsule the sutures between the different head sclerites, which are present in more generalised insects, have larvely disappeared. The only sutures which can be detected are: (1) the labro-clypeal suture, (2) the clypeo-frontal suture and (3) the gular sutures.

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(1) Through all this paper the description applies both to male and female unless otherwise stated.

The clypeus (Plate III, fig. 14 *cly;* Plate XII, fig. 83) is a narrow slightly arched sclerite at the sides of which are situated the two tentorial pits (Plate III, fig. 14 *tnp*) which are relatively prominent.

The gula is a slightly scleritised plate situated to the ventral region of the occipital foramen (Plate IV, fig. 27 *gu*). It projects anteriorly into the head cavity (Plate XII, fig. 83 *gu*) to receive the proximal ends of the maxillary cardine (Plate IV, fig. 27). At its lateral sides are two short gular sutures (Plate IV, fig. 27 *gus*).

Tentorium

All apodemes constituting a generalised tentorium are represented in the head of *Microbracon hebetor* Say though to a varying degree of development. The anterior arms (Plate III, figs. 20 and 21 *tna*) form the main parts and extend into the head cavity from the anterior tentorial pits to the occipital foramen in an almost horizontal direction. Their inner and outer sides expand in the region of their middle third to form faintly scleritised expansions or narrow lamellae which help to support the brain. A short distance posterior to its middle, each anterior arm gives attachment to a tentorial dorsal arm (Plate III, figs. 20 and 21 *tnd*), which is slender, and which arises on the ocular sclerite from the anterior side of the eye (Plate III, fig. 21). The dorsal arm is absent in *Apis mellifica* L. (Snodgrass, 1925), Near its posterior end, each anterior arm has a process (Plate III, fig. 20 *p*) which gives attachment to some of the maxillary muscles. The body of the tentorium is a narrow median band forming a bridge across the occipital foramen (Plate III, fig. 20 *tnb*). Posterior to the body of the tentorium are two very short posterior arms (Plate III, fig. 20 *tnpa* and fig. 21 *tnpa*), one on each side of the occipital foramen. The tentorial pits of the posterior arms are missing.

Antennae

The antennae are filiform, and are attached to the head near the centre of the face close to the median line of the frons (Plate III, fig. 14). Each antenna fits into a socket which has a well developed chitinous rim sometimes called the antennal sclerite (Plate V, fig. 33 *ansc*). On the lateral lower angle of this rim, there is a chitinous peg (Plate V, fig. 33 *chp*) which projects from the inside level of the rim into the socket, and which is pivoted to the base of a short radicle (Plate V, fig. 33 *rd*). This radicle is membranously attached to the rim of the socket, and is not generally counted by Braconid systematists as an antennal segment (Marshall, 1885).

Each antenna can be differentiated into a proximal and a distal part,

separated by a testaceous coloured zone (Plate V, fig. 29 *tcz*). The proximal part is composed of the radicle, the scape (Plate V, fig. 29 *sc*) — which is the largest segment of the antenna — and the pedicel (Plate V, fig. 29 *pd*). The distal part is the flagellum, and shows sexual dimorphism in the number of its segments, and hence in its length (Plate V, fig. 29). In the male the number of flagellar segments varies from 17 to 21; in the female there are 12 and rarely 13 segments. Of all the British specimens examined by the writer (2), no female possessed more than 13 flagellar segments, whereas 40 specimens from Berlin, all possessed 15-segmented flagellum (3). This variation in the number of flagellar segments bears a direct relation to the size of the insect (Schlottke, 1926).

In both sexes, the flagellum is often the seat of deformation and teratology of different characters. Plate V, figure 37, shows a case repeatedly encountered. Not infrequently, in the same insect, one flagellum has a segment more than the other.

The antenna, as a whole, is moved by means of muscles which have their origin on the dorsal and anterior arms of the tentorium (Plate V, fig. 31, *tna*) and which are inserted on a short tendon attached to the membrane between the radicle (Plate V, fig. 31 *rd*) and the chitinous rim (Plate V, fig. 31 *ansc*). In *Apis mellifica* L. the corresponding muscles are inserted on the basal knob of the antennae (Snodgrass, 1925). The flagellum is separately moved by means of longitudinal muscles having their origin on the consequently well developed scape, and their insertion on the proximal and of the pedicel. Another movement can be detected in the flagellum, mostly in its distal end. This movement varies from a simple curvature to a definite loop, and as there are no muscles or tendons in the flagellum, this movement is not easily accounted for. It might be suggested that it is brought about by blood pressure, or that the basement membrane contains a retractile element which is responsible for the action.

Each antenna is innervated by a double nerve which arises from the antennal lobe of the brain (Plate V, fig. 31 *anl*) and runs through the whole length of the antenna. A tracheal branch (Plate V, fig. 32 *tr*) and a blood vessel (Plate V, fig. 32 *bv*) supply each antenna and run close to, and parallel with, the nerve (Plate V, fig. 32 *nv*).

Johnston's Organ: On the distal end of the pedicel there is a circle of minute pits (Plate III, fig. 16); each pit leads to a group of elongated cells (Plate III, fig. 17) which, together with cells from the adjoining pits, form a cylindrical sheath running in the pedicel and scape. The writer could not

(2) The numbers dealt with were easily over one thousand.
(3) There is no doubt that the species is the same.

trace its joining to the antennal nerve in the scape as described by Child (1894). This organ is Johnston's organ which has been described in many insects, but not in any Braconid before. The pits here are too minute to be seen without cutting sections, and unlike those of most insects, they are not situated on the articulatory membrane, which is here very short (Plate III, fig. 17 *m*) but on the anterior wall of pedicel.

The antennal hair-like or trichoid sensillae are more or less scattered on the scape and pedicel; on the flagellum they are denser and of definite arrangement. Those on the radicle are of smaller size and are denser than those on the scape and pedicel.

A close examination of the antenna reveals an external ribbed appearance to the flagellum (Plate V, figs. 37, 38 and 39). Several clear longitudinal straps traverse each segment and separate darker areas to which the trichoid sensillae are restricted. The clear straps are the rhinaria (Plate V, fig. 38 *rh*) generally found on the antennae of most Parasitic Hymenoptera. The radicle, scape and pedicel are devoid of rhinaria. In *Doryctes gallicus* Reinh. (Braconidae), Seurat (1899) found that the first flagellar segment, as well as the scape and pedicel, is devoid of rhinaria. In the centre of each rhinarium there is a transparent elliptical zone (Plate V, fig. 38 *ez*) which corresponds to the surface area of a placoid sensilla. It seems that the place of the placoid sensilla in the rhinaria is different in different families of Hymenoptera. In *Evaniidae*, *Stephanidae* and *Chalcididae*, the sensilla lies in the basal half of the rhinarium; in *Ichneumonidae*, *Braconidae* and *Cynipidae* it lies in the centre. In *Oryssidae* it occupies the whole area of the rhinarium (Bischoff, 1927; Chrystal, 1930).

There is no difference in shape or size of the rhinaria in the two sexes. The length of the rhinarium varies from 60 to 100 μμ. The placoid sensilla (Plate V, fig. 38 *ez*) has a longitudinal diameter of 18 to 20 μμ, and a transverse diameter of 9 μμ.

In males the rhinaria are evenly distributed around each segment of the flagellum. In females there is a dorso lateral sector (Plate V, fig. 30) on the first flagellar segment which is devoid of rhinaria. In bees and wasps, Vogel (1923) found the same phenomenon, except that the sector which bears no sensillae in females and workers of those two families is not restricted to the first segment, but runs through all the flagellar segments.

The number of rhinaria of the male *Microbracon hebetor* Say is always greater than that of the female as shown on Table I which represents actual counts from cross-sections.

TABLE I

Number of rhinaria on each segment, starting from proximal end

POSITION		TOTAL
	Male	
Left	16, 16, 16, 19, 17, 18, 17, 15, 17, 17, 16, 16, 16, 15, 15, 15, 13, 7	292
Right	16, 16, 15, 17, 17, 18, 17, 15, 16, 16, 16, 14, 18, 15, 15, 14, 11, 2	279
	Female	
Left	3, 7, 12, 14, 16, 17, 20, 18, 17, 16, 16, 15	171
Right	3, 7, 12, 14, 15, 17, 19, 18, 15, 15, 16, 15	166

In females of *Doryctes gallicus* Reinh., Seurat found one rhinarium on the second flagellar segment, three on each of the following 16 segments and five on each of the last 12 segments; he did not give the details of those of the male, but mentioned that they are generally more numerous than in the female. It will be noticed that in both *Doryctes* and *Microbracon* the females have the least number of rhinaria on the proximal end segments of the flagellum, and a greater number is found on the distal end segments. Schulze (1924a) found that *Microbracon* males use the tip of their flagellum to support their body; this might account for the reduction in the number of rhinaria on the terminal segments of the male flagellum noticeable in Table I and shown in Plate V, figure 39.

Structurally the rhinarium is a canaliculus of the flagellar wall sunk under the general level of the cuticle and covered with an extremely thin membrane (Plate V, fig. 32 *m*), not more than 0.4 μμ in thickness. The two edges of the canaliculus are reflexed inwards and prolonged under the membranous cover (Plate V, fig. 32 *e*). At the middle, each caniculus has an elliptical area (Plate V, fig. 38 *ez*) where the chitinous bottom is missing (Plate V, fig. 34), and thus a pore is formed. This pore is the sensory pore through which the internal element of the placoid sensilla pass to communicate with the external cuticular element.

The external ribbed appearance of the flagellum is thus due to the difference in the intensity of light reflected or transmitted from (1) exposed chitin, (2) sunk chitin under the membranous cover. Where the chitin is exposed we get the dark appearance, where it is sunk and covered with membrane we get the clear straps corresponding to the rhinaria. Inside each rhinarium there are two parallel dark linear areas (Plate V, fig. 39 *e*) which give more effect to the ribbed appearance; these are the two reflexed edges of the rhinarium (Plate V, fig. 32 *e*) seen through the membranous cover.

It has been suggested that in the presumed olfactory organs of insects, receptors or processes of sensory cells are bathed, or, at any rate, moistened in a solvent liquid with which the particles of volatile stimuli combined (Berlese, 1909). This conception has not been generally accepted, since no glandular element has been discovered in connection with any of these organs. Furthermore, apart from Erichson's (1847) and Saulcy's (1891) observations, quoted by Berlese, the presence of this liquid has not been noticed. The present writer found that the rhinaria of *Microbracon* contain liquid. As to the source of this liquid, no exact suggestion can be made at this stage.

The hair-like or trichoid sensilla has a membranous cell, a chitogenous cell and a bipolar sense cell. All three cells lie within the ectoderm (Plate V, fig. 36 *tsn*).

The placoid sensilla has numerous sense cells with nuclei rich in chromatin (Plate V, fig. 36). In cross-section of a late pupal stage (just before casting the pupal skin), these sense cells are grouped round a vacule (Plate V, fig. 34 *vc*) opposite the sensory pore, and send out processes which meet in the vacule to form a terminal strand (Plate V, fig. 34 *ts*). This terminal strand ends very near the thin cuticular plate covering the whole rhinaria. Unlike the case in the trichoid sensilla, the sense cells here are subectodermal; they bulge into the body cavity of the antenna carrying with them the basement membrane (Plate V, fig. 36). The nerve fibres at the bases of these sense cells gather together to form a nerve branch (Plate V, fig 36 *nvb*) which joins the antennal double nerve, not in the same flagellar segment in which the sensilla lies, but in the segment proximal to it (Plate V, fig. 36). In sections of adult antenna the sensory cells of neighbouring sensillae of every segment merge together to form one continuous layer beneath the ectoderm (Plate V, fig. 32).

In Plate V, fig. 36, there are two large nuclei on each side of the sensory pore. These might be the nuclei of the chitogenous cells of the placoid sensilla.

According to Bischoff (1927) the placoid sensillae are said to be the only type of sensillae present in the antennae of *Braconidae*, *Cynipidae*, and *Evaniidae*. Besides the trichoid and placoid sensilla described above, the present writer found a third type on the flagellum of *Microbracon*. Near the edges of the rhinaria, there are some extremely small coeloconic sensillae (Plate V, fig. 35) of the type commonly known as the « shallow pit peg » or « champagne-cork » (Snodgrass, 1927). The nerve running in the core of this sensillae joins the nerve fibres at the bases of sense cells of the same segment.

Mouth parts

The mouth is a transverse opening situated between the movable mouth parts. Its anterior border is formed by the membranous epipharynx strengthened by the labrum (Plate XII, fig. 83). Its posterior border is formed by the hypopharynx backed by the labium. The maxillae and mandibles form the two lateral borders (Plate III, fig. 21). The opening of the salivary duct is outside the mouth and is situated on the labium, ventral to the hypopharynx (Plate IV, fig. 28).

The epipharynx is a non scleritised prolongation of the dorsal wall of the pharynx projecting to the exterior (Plate III, fig. 18 *ep*). It is attached to an inward curved edge of the labrum and bears numerous hairs which serve as protection to the mouth.

The hypopharynx is well developed (Plate IV, fig. 26 *hyp*) and has faintly scleritised edges (Plate IV, fig. 28). As the ephipharynx, it is clothed with hairs to protect the mouth. In *Doryctes*, Seurat (1899) mentions neither an epipharynx nor an hypopharynx.

The labrum is separated from the clypeus by a narrow labro-clypeus suture (Plate XII, fig. 83). It is a concave plate with a curved wide basis and a narrow distal end (Plate IV, fig. 22).

The combined mentum and submentum of the labium form a scleritised boat-shaped trough which carries at its lateral sides the three-segmented palps (Plate IV, fig. 26); inside this structure the labial muscles extend. The glossa is single-lobed having on its dorsal and lateral sides numerous small protuberances arranged in rows (Plate IV, fig. 28). These protuberances have minute prolongations and, no doubt, help in holding the lapped liquid while it is conveyed to the mouth. The paraglossae are poorly developed and consist of two small lobes, one on each side of the glossae. They can be distinguished by two characteristic rows of spines, one on each paraglossa (Plate IV, fig. 28 *pg*). Near each paraglossa the labium has five sensillae (Plate IV, fig. 28 *sn*).

The cardines of the maxillae proved difficult to find. Their proximal ends articulate with the inwardly projecting distal end of the gula and form with it an acute angle. Each cardo is sub-triangular in shape with an articulate knob at its proximal end (Plate IV, fig. 25). The outer edge of the cardo is thickly scleritised into a ridge. The stypes (Plate IV, fig. 24 *st*) are well scleritised at their bases, and laterally they carry the five-segmented maxillary palps. The galea (Plate IV, fig. 24 *g*) is well scleritised, with a keel to the outside and encases the membranous lacinea (Plate IV, fig. 24 *l*).

The mandibles are strong and well developed; they are jointed to the head by a narrow membranous joint (Plate III, figs. 14 and 15). Each mandible is bidentated and has the form of a triangular pyramid (Plate IV,

fig. 23). The outer surface is slightly convex and has at its basis a keel which extends for a short distance; at the distal end each mandible bears several sensillae. The adductor muscles are inserted on the inner basis of the mandible and originate at the posterior and dorsal wall of the head; they are fan-like and more developed than the abductors which are inserted on the outer mandibular base, and which originate at the sides and back of the head.

Thorax

The thorax is attached to the head by a flexible neck which is devoid of cervical sclerites. The cuticle of the neck, and that of the joint between the propectus and the rest of the thorax (Plate VI, fig. 41), is composed of a relatively thick chitinous layer, the external surface of which is thrown into numerous protuberances. Each protuberance has a minute process at its summit (Plate VIII, fig. 61). This extraordinary modification of the cuticle is found nowhere else in the body wall of this insect. The worker is unaware of any account of a similar modification, which is probably designed to allow a large amount extensibility.

Prothorax

The pronotum (Plate VI, fig. 40 *n1*) is entirely detached from the rest of the prothorax and is solidly connected to the front of the mesothorax. Its lateral edges extend down on both sides and end ventrally between the procoxae and the mesosternum (Plate VI, fig. 41). The pronotum is subdivided by an external depression into a narrow anterior part and a posterior part (Plate VI, figs. 40 and 44). The posterior part is prolonged backwards until it reaches the tegula (Plate VI, fig. 40 *teg*). Snodgrass (1925) suggests that these two divisions are probably the scutum and scutellum.

The propectus carries the anterior pair of legs and is extremely mobile. It consists of the prosternum (Plate VI, fig. 41 *s1*) and of two relatively large pleural plates which curve round and extend ventrally until they almost meet in the median ventral line (Plate VI, fig. 41 *eps;* Plate VII, fig 48). While most authors regard these two plates as the propleural plates, Crampton (1926) and Martin (1916) regard them as cervical sclerites. Dorsolaterally, each of these two plates is traversed by a faint suture which separates a faintly scleritised triangular division (Plate VII, figs. 48 *y* and 49 *y*) from the rest of the plate. This suture has no connection with the articulation of the coxa, and thus cannot be regarded as a pleural suture. On its lateral posterior angle, each pleuron has a slender process (Plate VII, figs. 48 *x* and 49 *x*), which arches medially. The homologies of these two parts

(Plate VII, fig. 48 *x* and *y*, and fig. 49 *x* and *y*) are difficult to ascertain and, for the present, they must be regarded, generally, as integral parts of the propleura.

On its lateral anterior end, each propleural plate has a characteristic small process (Plate VII, figs. 48 *os* and 49 *os*) which extends forward and loosely articulates with the occiput. Snodgrass (1911) refers to this process as the occipital. In *Microbracon hebetor* Say, the posterior end of this process elongates backwards and projects into the body cavity, to give insertion to muscles originating on the profurca (Plate VII, fig. 48). On its ventral surface the occipital process has several sensillae arranged into two groups (Plate VII, fig. 50); similar sensillae are situated on both sides of the occipital foramen (Plate IV, fig. 27 *sn*). In the male the occipital process is shorter and broader than it is in the female; this character is so clear and stable to the extent that by applying it, one can differentiate, with certainty, a male's from a female's prothorax.

The main body of the prosternum is a semi-pentagonally-shaped plate having its two lateral edges curved inwards, and the anterior margin curved outwards (Plate VII, fig. 45). Anteriorly, the prosternum is overlapped by the propleural plates (Plate VI, fig. 41). It bends upwards to form the posterior border of the propectus (Plate VII, fig 49 *s1*). From its two posterior lateral corners, its sends out two arms (Plate VII, figs. 45 *a*, 48 *a* and 49 *a*); each arm bends to articulate with the propleural plate of its side, and thus a circular membranous area is enclosed. The articulation of the anterior coxa (Plate VII, fig. 49 *cxc1*) lies at the anterior part of this membranous area, the propleural plate forming the anterior border of the articulation while the prosternum does not take any part in it.

The prosternum is not divisible into a basisternum and a furcisternum, the motted lines in Plate VII, figure 45 represent the furcal ribs seen through the sternum. The furcal pit (Plate VII, fig. 45 *f1p*) is well marked.

The furca of the prosternum is well developed (Plate VII, figs. 47, 48 and 49). Its stems and arms are prolonged into broad lamellae which are strengthened by fine ribs. The furcal stem stands on the sternum with a V-shaped basis (Plate VII, fig. 47).

Mesothorax

The mesothorax is well developed and constitutes more than two thirds of the size of the alitrunk (Plate VI, fig. 40). This is apparently due to the fact that the mesothorax is the seat of the large indirect wing muscles which serve as elevators and depressors not only to the anterior pair of wings but also to the posterior pair.

The mesonotum is a dome-like structure divided by an inverted V-shaped

suture (Plate VI, fig. 42 *k*) into an anterior scutu-prescutum and a posterior scutellum (Plate VI, fig. 42 *sctl2*). This external suture marks a strong internal notal ridge (Plate XII, fig. 88 *nr*).

The scutu-prescutum is the combined scutum and prescutum which are not differentiated as separate plates in this insect. It bears the anterior notal wing process (Plate VI, fig. 42 *awp*) and the posterior notal wing process (Plate VI, fig. 42 *pwp*). It is traversed by a very faint suture (Plate VI, fig. 42 *h*) which is not marked internally by a corresponding ridge. Along the middle part of this suture, and to the posterior side of it, is a row of fine punctuation (4). Another faint suture starts behind the posterior notal wing process and curves upwards for a short distance and then comes to an end (Plate VI, fig. 42).

The rear margin of the scutellum is deflected into a thick reduplication and its ends are prolonged into the axillary cord (Plate VI, fig. 42 *axc*).

Posterior to the scutellum, the postnotum or phragmanotum lies hidden under the metanotum (Plate VI, fig. 42 *pn2*). It consists of the postscutellum and the posterior phragma of mesonotum. When dissected out it will be seen that it shows signs of incomplete division along its median line (Plate VI, fig. 43). The phragma (Plate VI, fig. 43 *ph2;* Plate XII, fig. 88) is relatively large and extends inwards and backwards into the body cavity to give attachment to the median longitudinal indirect wing muscles.

The anterior phragma of the mesonotum is small and is situated, internally, at the anterior end of the mesonotum (Plate VI, fig. 41 *ph1*).

The mesopleuron is highly specialised. Externally the pleural suture is not continuous between the coxal articulation and the pleural wing process (Plate VI, fig. 40), a case which adds to the difficulties of determining the different sclerites of the pleuron. However, if we examine the pleuron from the internal side (Plate VII, fig. 52) it will be found that the pleural ridge, corresponding to the pleural suture, is continuous from the coxal articulation to the pleural process (Plate VII, fig. 52 *plp*), altough its dorsal anterior end is not as strong as its ventral posterior part. It thus separates a narrow faintly scleritised epimeron from the rest of the mesopleuron, i.e. episternum. All the three parts labelled *eps2*, *preps* and *z* (Plate VI, figure 40; Plate VII, figure 52) collectively form the episternum.

In the small membranous area under the tegula, and anterior to the pleural wing process there is a basalare or episternal plate [paraptera of Snodgrass] (Plate VI, fig. 40 *apr*), and behind the pleural process there is a pleural or subalare plate (Plate VI, fig. 40 *ppr*).

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(4) The dotted lines *q* and *j* (Plate VI, fig. 42), do not represent sutures but show the borders of the areas on which indirect wing muscles are inserted.

There is no distinct mesosternum. The main part of the episternum (Plate VI, fig. 40 *eps2*) and the sternum form one plate, the ventral side of which is here regarded as the sternum because it carries the furca. This ventral part is not divided by any sutures, but along the median longitudinal line there is an infold (Plate VI, fig. 41) which marks the internal longitudinal plate or lamella of the mesofurca (Plate VII, fig. 52 *fpl*). Near the coxae (Plate VI, fig. 41) another two short infolds, which mark the internal basis of the furca, converge to the median line. The three infolds meet at the furcal pit (Plate VII, fig. 46 *fp*). At the anterior end of the median infold (Plate VI, fig. 41) there is another small pit, which is marked internally by a peg. This is no doubt the detached anterior end of the plate *fpl* (Plate VII, fig. 52).

The mesofurca is relatively well developed (Plate VII, figs. 52 and 53). The two arms of the furca are medially bridged with an arch under which the anterior part of the meso-metathoracic nerve centre is situated. Each arm of the furca is connected laterally to a short arm from the pleural ridge (Plate VII, figs. 52 and 53 : pleural arm *pla2*) by a fan-like prolongation. The mesofurca is anteriorly strengthened by a median longitudinal lamella (Plate VII, fig. 52 *fpl*) to which reference has already been made.

Metathorax

The metathorax is very much reduced (Plate VI, figs. 40 and 42). The metanotum is a narrow plate situated posterior to the mesoscutellum. It is divisible into prescutum, scutum and scutellum. Posteriorly it articulates with the anterior border of the large first abdominal tergum (propodeum). The metapleuron consists of two plates separated by an oblique suture. The anterior dorsal plate is less scleritised than the posterior ventral one, and bears the pleural wing process. Both plates articulate with the first abdominal tergum. Anterior to the pleural wing process, there is a small basalare plate. The metasternum (Plate VI, fig. 41 *s3*) is a narrow plate notched at its median posterior end, and at its centre is situated the metafurcal pit. The anterior edges of the metasternum are reflexed inwards (Plate VII, fig. 54 *s3*).

The metafurca differs essentially from the mesofurca (compare fig. 53 with fig. 54 in Plate VII). It has no arch, and its lamella is transverse (Plate VII, fig. 54 *fpl*). The metapleural arms (Plate VII, fig. 54 *pla3*) are more developed than the mesothoracic pleural arms.

The first abdominal tergum is solidly articulated to the metathorax, and together with the thorax form the alitrunk. At its posterior border, the first abdominal tergum, which forms the propodeum of this insect, has a

semicircular notch (Plate VI, fig. 41) into which the second abdominal tergum fits and a unique articulation is formed (5).

Wings

The anterior pair of wings (Fig. 2) is dark at the bases and hyaline. Each wing is 2.7 mm. long and 1.0 mm. across its widest part. It has a

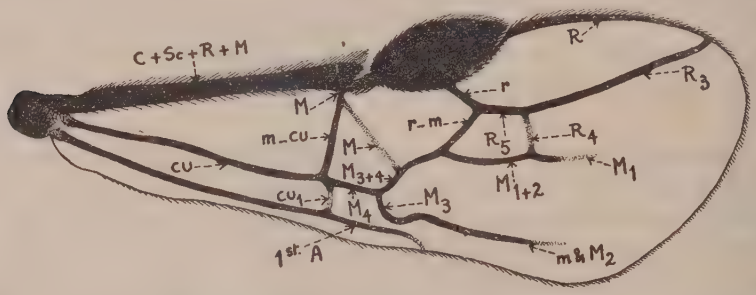

Fig. 2. — Right anterior wing with nomenclature based on Comstock-Needham system.

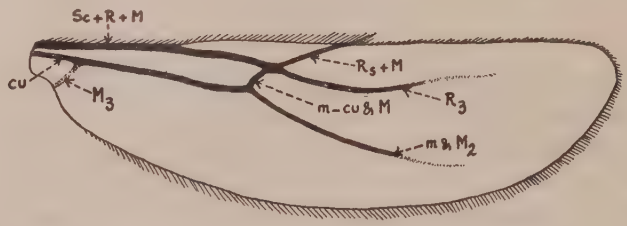

Fig. 3. — Right posterior wing with nomenclature based on Comstock Needham system.

parastigma (Plate VIII, fig. 56 dark area) which bears several sensillae similar to the sensillae on the basis of the wing described by Newton (1931).

Overhanging the anterior side of the wing articulation, is a well developed tegula (Plate VI, fig. 42 *teg*). The articulary sclerites or axillaries are three in number (Plate VIII, fig. 58 *1ax*, *2ax* and *3ax*) ; axillary four is wanting. The first and third axillaries are relatively large, the second is small. Besides the axillaries there are four plates at the basis of the wing. The anterior plate (Plate VIII, fig. 58 *p*) is regarded by some authors as the base of the subcosta on account of its articulation with the first axillary sclerite. The

(5) Thoracic spiracles are described under « Respiratory system », page 37.

other three plates are the median plates of Snodgrass. Several sensillae of the type so called «olfactory pores» are found on the anterior plate (Plate VIII, fig. 58 *p*) and on the anterior two of the three median plates.

The posterior pair of wings are lighter in colour than the anterior pair. Each wing is 2.0 mm. long and 0.6 mm. across its widest part.

The articulary sclerites are the same as in the anterior wing but,

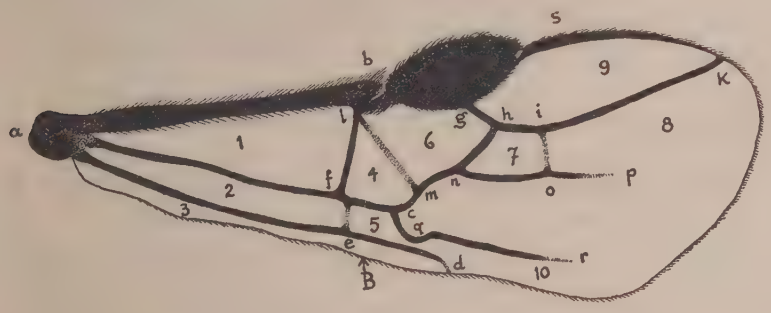

Fig. 4. — Right anterior wing with nomenclature based on Marshall's system for *Braconidae*.

Longitudinal veins: *ab*, costa and subcosta united; *aed*, pobrachial; *afc*, praebrachial; *ghik*, radius [*gh*, first abscissa; *hi*, second abscissa; *ik*, third abscissa]; *lmnop*, cubitus; *qr*, anal; *sk*, metacarpus.

Transverse veins: *hn*, first intercubital; *io*, second intercubital; *cm*, interior discoidal or recurrent; *lf*, praebrachial transverse; *fc*, pobrachial transverse.

Cells (areolets): 1, praebrachial; 2, pobrachial; 3, axillary; 4, praediscoidal; 5, podiscoidal; 6, first cubital; 7, second cubital; 8, third cubital; 9, radial; 10, anal.

B, rib on which hamuli of posterior wing catch.

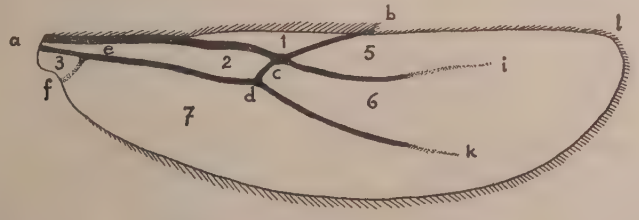

Fig. 5. — Right posterior wing with nomenclature based on Marshall's system for *Braconidae*.

Longitudinal veins: *acb*, subcostal; *aed*, praebrachial; *bl*, metacarpus; *ci*, radius; *dk*, cubitus; anal shown in Plate VIII, figure 57.

Transverse veins: *cd*, praebrachial transverse; *ef*, pobrachial transverse.

Cells (areolets): 1, costal; 2, praebrachial; 3, pobrachial; 5, radial; 6, cubital; 7, discoidal.

of course, they are much smaller. Only two median plates are present in the posterior wing (Plate VIII, fig. 57).

Wing venation: The venation of the anterior wing is of the usual Braconid type. It is interesting to note that the median «M» (Fig. 2) which is missing in *Ichneumonidae* is here conspicuously weak.

In naming the veins in Figures 2 and 3, the worker applies the Comstock-Needham system of nomenclature which is, no doubt, valuable from the morphological view point. But in Hymenoptera, where there is a large amount of coalescence and reduction in venation, the use of the Comstock-Needham system becomes inconvenient and consequently has not been generally adopted. Therefore, the veins are renamed in Figures 4 and 5 according to Marshall's horismology of *Braconidae* (1885).

In the anterior wing (Fig. 4), the second cubital cell is small (smaller than that of *Microbracon brevicornis* Say). The first and second abscissa of the radius are nearly of the same length. The radius attains wing margin near the apex.

In the posterior wing the anal (Plate VIII, fig. 57) is very much reduced and the pobrachial absent altogether (Fig. 5).

Wing coupling apparatus: The wing coupling apparatus consists of three minute hamuli localised at the distal end of the subcostal vein of the posterior wing (Fig. 5) and of a thickened rib at the anal margin of the anterior wing (Fig. 4B).

Wing muscles: The anterior pair of wings has two categories of muscles: (1) Indirect wing muscles, and (2) direct wing muscles.

(1) The indirect wing muscles consist of:

(a) A set of longitudinal muscles on each side of the median dorsal line of the thorax (Plate VIII, fig. 55 *imp*). Anteriorly these muscles are attached to the scutu-prescutum on the area externally bordered by the dotted line «*q*» (Plate VI, fig. 42) Posteriorly, the longitudinal muscles are attached to the posterior mesophragma (Plate XII, fig. 88).

(b) A set of oblique dorso-ventral muscles on each side of the longitudinal muscles (Plate VIII, fig. 55 *idv*). Anterio-dorsally these muscles are attached to the interior lateral side of the scutu-prescutum, on the area externally limited by the edge of the mesonotum and the dotted line «*j*» (Plate VI, fig. 42). Posterio-ventrally the oblique dorso-ventral muscles are attached to the sternum (Plate VIII, fig. 55 *idv*). The indirect wing muscles serve as depressors and elevators to both pair of wings, and are composed of relatively enormous muscle fibres which are dirty white in colour. The area of the scutu-prescutum where the indirect muscles are attached has a dark colour.

(2) The direct wing muscles lie against the inner face of the pleuron arranged in layers one behind the other (Plate VIII, fig. 55 *dm*) ans consist of :

(a) An extensor or pronator set of muscles which lies most interior of all direct muscles and which is the largest of all ; it is inserted on a special disc, the pronator disc (Plate XII, fig. 88 *ap*) ; this disc is connected by a chitinous prolongation to the anterior paraptera or the basalare and is attached to the adjacent part of the episternum.

(b) Two fan-shaped flexor muscles inserted on the third axillary sclerite by means of tendons.

(c) A fan-shaped muscle inserted on the first axillary sclerite by a short tendon.

(d) A comparatively small muscle arising near the pleural arm and inserted on the subalar plate.

The posterior pair of wings possesses no indirect wing muscles, and each has a set of direct wing muscles corresponding to those of the anterior wing (a) (b) and (c). The pronator muscle of the hind wing has no pronator disc and is inserted by tendon on the metabasalare.

Legs

The three pairs of legs differ enormously in length (Plate VIII, fig. 59) and consist of the usual leg segments.

The fore leg has a freer movement than the middle and hind legs. Its coxa is nearly square in shape. The tibial spur and metatarsus are modified to serve as antannae cleaner (Plate IX, fig. 69). The proximal part of metatarsus is curved and fringed with a comb-like row of bristles. The spur is relatively large and flat and is also provided with bristles similar to those on the metatarsus.

During breeding an interesting deformity of the right anterior leg was encountered in a male pupa (Plate VIII, fig. 60 *fg*). That leg was deformed to a sort of stump carrying a segmented ring. However, at its last developmental period the pupa failed to be transformed into adult.

The coxa of the middle is pear-shaped, that of the hind leg is elongated (Plate VIII, fig. 59). Each of the middle and hind coxae has a small meron which carries a characteristic group of 7-8 sensillae (Plate VII, fig. 51).

The two small segments between the coxa and femur have been regarded as the first and second trochanter. The anatomy of this part in *Microbracon hebetor* Say shows that the reductor femoris muscles are inserted on the base of the distal segment, and that the flexor muscles of the tibia are also attached to the same fold. This anatomical fact was observed by Snodgrass (1927) and led him to conclude that the so called second trochanter

in most of the Hymenoptera Parasitica, is morphologically a basal part of the femur.

Praetarsus: The distal segment of the tarsus or the distitartus — as it is sometimes termed by some authors (Crampton, 1923) — carries terminally an organ composed of several parts. Some workers refer to these parts separately, others give the compound structure a collective name. Schiodt termed it the *ungus* or *ungula*, De Meijere (1901) and Arnhart (1923) respectively called it *praetarsus* and *claw segment* (krallenglied). Snodgrass (1927) suggests that this organ «might appropriately be termed *foot* but not with those insects that place a part or all of the tarsus on the supporting surface»; however, he adopts De Meijere's nomenclature simplified to *praetarsus*. Ewing (1928) and Imms (1931) employ this term. MacGillivray (1923) calls this organ *articularis* and objects to the use of the term praetarsus on the grounds that it is « a misnomer at best for the articularis is in reality a post-tarsus ». In the present paper the term *praetarsus* is used as it is now accepted by the majority of entomologists.

In *Microbracon hebetor* Say the praetarsus is the same in all legs and in both males and females. It is of a complicated type, composed generally of two lateral strongly scleritised claws (Plate IX, fig. 62 *cl*), and a median so called adhesive organ, which is a membranous bag supported dorsally and ventrally with chitinised plates and terminating in a soft lobe or arolium which can be folded or out-spread according to use. The cavity of this organ is continuous with the body-cavity of the last tarsal segment, whose end is thickly scleritised to form a connecting edge for the adhesive organ (Plate IX, fig. 62 *ed*).

Claws: Each claw is cleft into a dorsal hook curved downwards and a ventral lobe carrying two sensory hairs. From the basi-dorsal side of the hook arises a prominent bristle which has its basis deeply embedded in the main body of the claw (Plate IX, fig. 62 *br*). The colour of the hook (and that of the claw generally) varies from dark brown to black in insects bred in low temperature but is testaceous in those bred in temperature above 24° C. The main body of each claw is less scleritised than the hook and is clothed with hairs. Each claw has two processes facing the median adhesive organ and embedded in its walls. One of these processes is latero-dorsal, the other is latero-ventral. The claws open into the adhesive organ between these two processes. Plate IX, figure 66 shows the opening of the claws into the adhesive organ, and one of the latero-dorsal processes *ldp*. The section is oblique and does not pass through the latero-ventral process.

Unguifer: The bases of the claws move on the knobbed end of a V-shaped piece (Plate IX, fig. 63 *ung*) which is connected by a short articular membrane

to the dorsal end of the last tarsal segment. This piece corresponds to the « krallenhöker » of Dahl, Ockler and De Meijere, to the « unguifer » of Crampton (1923), and the « tubercula » of MacGillivray (1923). Crampton describes the unguifer as a dorsal process; Snodgrass (1927) defines it as a « median process of the distal end of the last tarsal segment ». In *Microbracon hebetor* Say, this articular piece is not a process of the last tarsal segment, but, as was stated before, a separate piece connected to that segment by a short membrane. MacGillivray terms this piece tubercula and defines it as a projection or emargination against which the claws and orbicula articulate.

Orbicula: Dorsally the adhesive organ has a plate (Plate IX, fig. 63 *orb*) which has been termed the supporting plate (stutzplatte) by both Ockler (1890) and Arnhart (1923), the pressure plate (druckplatte) by Dahl (1884), the protective plate (schutzplatte) by De Meijere (1901) and the orbicula by MacGillivray (1923). Crampton (1923) does not mention it. The proximal end of this plate narrows and curves ventrally and is membranously connected to the unguifer. The distal end of the orbicula lies in a sort of a cavity formed by the folding of the arolium (Plate IX, figs. 63 and 65). The two lateral edges of the orbicula are reflexed ventrally in the manner shown in Plate IX in the two figures 65 and 66. The basis of the orbicula sometimes rests on the two arms of the v-shaped unguifer midway between the apex and the knob articulating with the claws. On its dorsal surface, the orbicula bears four sensory hairs of equal length, characteristically arranged as shown in Plate IX, figure 63, and two comparatively large dome-like or campaniform sensillae (Plate IX, fig. 63 *cs*). The sensory hairs on the orbicula differ in different Hymenopterous families. De Meijere describes two strong hairs or bristles in *Formica*, and two strong and many smaller in both *Bombus* and *Vespa*. In the honey-bee worker, Snodgrass (1925) describes five long hairs arranged in a line across the base of the orbicula and curve over the arolium.

Calcanea: On the ventral wall of the membranous adhesive organ is a comparatively large plate (Plate IX, fig. 62 *cal* and fig. 64 *cal*) called the *extension plate* (streckplatte) by Dahl, Ockler, De Meijere and Arnhart, the *unguitractor* by Crampton and the *calcanea* by MacGillivray. The two latero-ventral sides of this plate are serrated, and at its distal end each side of the plate carries a strong sensory hair (Plate IX, fig. 62). The calcanea is retracted into the last tarsal segment by means of the tarsal-muscle tendon (Plate IX, fig. 62 *tn*) which is attached to the calcaneal proximal end and which is worked by the tibial muscle. In the act of being retracted the calcanea has its ventral surface gliding on the

strongly scleritised infold of the median ventral part of the last tarsal segment which is termed *gleitflache* (Plate IX, fig. 62 *fl*) by De Meijere. When the calcanea is retracted it causes the claws to be reflexed backwards and outwards as they usually are, when not in use.

Distal to the calcanea on the ventral wall of the membranous adhesive organ is a very faintly scleritised area termed the *planta* (Plate IX, fig. 62 *pl*). This area is covered with small hairs and in other insects it is usually more scleritised than it is here.

Arolium: The membranous part of the adhesive organ which lies distal to the orbicula and planta is usually termed the arolium (Plate IX, fig. 62 *ar*). It has a narrow scleritised *band* or *bow* (Plate IX, fig. 62 *bw*) which embraces the ventral, lateral and some of the dorsal sides.

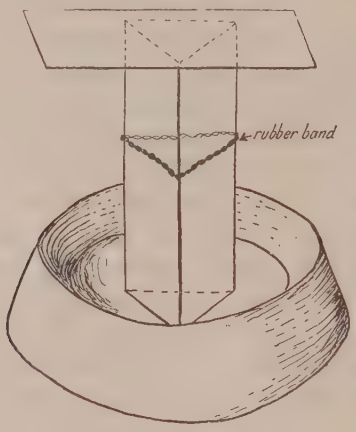

Fig. 6.

In many insects the arolium bears tenent hairs which are very small modified glandular setae responsible for the secretion of adhesive fluid which enables those insects to climb smooth surfaces. The writer could not see these hairs in *Microbracon hebetor* Say, probably they are too small to be seen by the magnification available or they are absent.

When the insect climbs a hard smooth surface, the bow is flattened and the arolium is thus spread open and pressed against the substratum. Plate IX, figure 67 shows the arolium half open. In walking on a smooth flat surface the arolium is used, but in this case it is folded (Plate IX, figs. 62 and 63). In both these cases the claws are reflexed backwards and outwards, and only come in use when the insect is climbing or walking on rough surfaces.

Microbracon hebetor Say can with great ease climb perpendicular smooth

surfaces, and can walk on the lower side of horizontal or slanting glass. The way by which this is accomplished is not clear. The following experiment was carried out.

Four slides were left in alcoholic eosin for 8 hours. After drying, they were microscopically examined. A thin homogeneous film of the stain was deposited on their surfaces. The slides were then arranged as shown in Figure 6. Some adult *Microbracon* were placed inside. The insects freely ascended and descended, they also walked on the under surface of the covering top slide. After a time the slides were subjected to careful high power microscopic examination. No foot prints were found at all. Thus in the absence of any fluid, ascending cannot be due to adhesion or seizure as conclusively shown by Gillett and Wigglesworth (1932) in case of the adult *Rhodnius prolixus* (Hemiptera). The way of descending and walking on the under surface of a horizontal slide in *Microbracon* is, yet, more difficult to understand.

In the following Table II the nomenclature used by different authors for the tarsal parts is tabulated.

Abdomen

General features common to both sexes

The abdomen in both sexes is composed of nine terga and ten sterna; the membranous part anterior to the anus (Plate X, fig. 71; Plate XI, fig. 76) may theoretically be considered as the tenth tergum. Another way of explaining the morphology of this region is to regard the anus as being carried by the tenth segment and that only the sternites of this segment are scleritised and the rest is membranous. In *Doryctes*, Seurat (1899) found that the abdomen is formed of only nine segments and that the last one bears the anus.

The first abdominal tergum is shifted to the thorax (Plate VI, fig. 40 *I*), a normal hymenopterous feature. But it is interesting to note that the first abdominal sternum still lies in the abdomen, a case which differs from most hymenoptera, and which is also found in *Sycosoter lavangei* (Braconidae) (Lichtestein and Picard, 1918), and in *Doryctes gallicus* Reinh. (Braconidae). Marshall (1885), Snodgrass (1909 and 1910) and Fahringer (1928) do not mention anything about this point; and at this stage the present investigator cannot tell if it is a feature common to all *Braconidae* or not. In *Microbracon hebetor* Say this first abdominal sternum is reduced to a narrow scleritised strip, which is broadened at its articulation with the second abdominal tergum (Plate X, fig. 74 *Is*). On this, relatively broad, lateral articulate side the first abdominal sternum carries numerous small sensillae (Plate X, fig. 74 *sn*). It is noteworthy that these particular sensillae

TABLE II

AUTHORS	NOMENCLATURE OF PRAETARSAL PART					
DAHL	—	krallenhböcker	pressure-plate druckplatte	extension-plate streckplatte	—	chitinous bow chitin-bogen
OCKLER	—	krallenhböcker	support-plate stützplatte	extension-plate streckplatte	strecksohle	elastic bow elastischer bogen
DE MEIJERE	praetarsus	gelenhböcker	protective-plate schutzplatte	extension-plate streckplatte	strecksohle	—
ARNHART	claw segment krallenglied	—	support-plate stützplatte	extension-plate streckplatte	sohle	bow bögel
CRAMPTON	—	tubercula	—	unguitractor	—	—
MACGILLAVRAY	articularis	unguifer	orbicula	calcanea	planta	camera

occur at the ventral side of the two restrictions of the body. As was already mentioned, they occur on the occipital process (Plate VII, fig. 50) and on the two sides of the occipital foramen (Plate IV, fig. 27 *sn*) ; and here they occur between the alitrunk and the gaster.

All terga are scleritised ; the seventh tergum is the last visible one, the eighth and ninth are telescoped into it (Plate X, figs. 70 and 73). The first eight terga bear spiracles (described under respiratory system).

The second abdominal tergum is small and nearly square in shape (Plate X, fig. 72 *II*). It extends only a short distance on eitheir side of the longitudinal median line. It has two arching carinae (Plate X, fig. 72 *k*). This tergum is characteristically divided into areas which, in their relative position, form a parallel to the division of a thoracic notum into prescutum, scutum and scutellum. The area *IIt* (Plate X, fig. 72) is parallel to the prescutum, the area carrying the spiracle is parallel to the scutum and the dark coloured area is parallel to the scutellum. From the systematic view point, this tergum is important and is usually referred to as the first abdominal tergum (not counting the propodeum).

The third abdominal tergum is usually lighter in colour than the rest of the visible terga (Plate X, figs. 70 and 73). Its posterior end lies in juxtaposition with the anterior end of the fourth abdominal tergum without any intersegmental membrane between them ; this character is common to most *Braconidae*.

The abdominal sterna are almost membranous (sterna, one in both sexes, eight and nine in male are excepted). Sterna three to seven, and sternum ten, each carries a pair of scleritised sternites on its lateral borders (Plate X, fig. 70 *stn*, and fig. 73 *stn*). The sternites of the tenth sternum are subcrescentic in shape, and are situated ventral to the anus (Plate XI, fig. 77 *xs*). In *Doryctes* (Seurat, 1899) each of the nine sterna is one continuous scleritised plate, more or less similar in shape to the terga.

The cerci in both sexes are situated in the membranous area posterior to the ninth tergum (Plate XI, fig. 76 *cr*, and fig. 77 *cr*). Each cercus consists of one segment carrying long bristles (Plate XI, fig. 78 *cr*).

Abdomen of female

The size of the abdomen in the female is, generally, slightly larger than that of the male.

The female's eighth tergum is prolonged on both sides of the abdomen (Plate XI, fig. 76 *VIII*). The ninth tergum together with parts of the eighth and ninth sterna are modified to form the genitalia which are described under the reproductive system.

Abdomen of male

The eighth and ninth sterna of the male are the only two completely scleritised sterna in the abdomen; each one of these two sterna forms a narrow continuous plate. The male genital armature is situated between the ninth and tenth abdominal sterna.

In the male, the hypodermal cells underlying the anterior part of the eighth abdominal tergum, are modified to form a compact gland (Plate X, fig. 71 *gl*). This gland extends across the tergum and consists of one layer of columnar epithelial cells with large spherical nuclei (Plate X, fig. 75). The anterior border of the gland is level with the anterior end of the tergum, which has a characteristic transverse thickening, not found in other terga.

The present worker was unable to find any ducts or external openings to this gland; furthermore, the part of the tergum overlying the gland is thick and heavily scleritised. These facts suggest that the function of the gland is probably internal. Work is being carried on to find the true function of this gland and at present, there is no use to speculate on this point.

As far as the present worker is aware this gland has not been found or described before. The so-called scent gland on the seventh abdominal tergum in *Apis mellifica* L. is found in the worker and the queen and is missing in the male. James (1926) describes a pair of glands one on each side of the eighth abdominal segment in *Harmolita*, but again these are found in females and are missing in males. In both these two cases the glands have external openings unlike the glands found in *Microbracon hebetor* Say which have no openings. Various unicellular glands have been described in bees and wasps, but these are mostly situated on the ventral abdominal plates and on their inter-segmental membrane.

Alimentary canal

The alimentary canal forms a tube running from the mouth to the anus (Plate XII, figs. 83 and 88); the diameter of this tube differs at different parts. It is longer than the body and, consequently, is bent into loops. The colour of the alimentary canal is white, almost transparent, so that the contents can be seen through the walls of the gut. It is differentiated into fore-gut or stomodeum, hind-gut or proctodeum and mid-gut or ventriculus. The fore and hind guts are internally lined with chitinous intima.

The malpighian tubules open into the alimentary canal at the junction between the mid and hind guts (Plate XIII, fig. 95).

The thoracic or salivary glands have no connection with the alimentary canal and open on the labium under the hypopharynx as was already mentioned.

Fore-Gut

The fore-gut comprises the pharynx, the oesophagus, the crop, and the proventriculus or gizzard (Plate XII, fig. 86 *prv*).

The *pharynx* extends from the mouth to the beginning of the oesophagus (Plate XII, fig. 83). The point of differentiation between the pharynx and the oesophagus is the insertion of the muscles which originate in the frons of the head. The pharynx stands vertically in the head and nearly at right angles to the oesophagus. It has a powerful muscular coat and other muscles arising from the facial wall of the head are inserted on its walls.

Histologically the pharynx consists of an innermost chitinous layer, a layer of epithelial cells resting on a basement membrane and a muscular coat.

A short distance from the mouth the chitinous layer in the floor of the pharynx is scleritised into a strong pharyngeal plate (Plate XIII, fig. 92 *php*), the anterior arms of which rest on the two posterior sides of the hypopharynx. The posterior arms of this plate are comparatively long and curve upwards in the lateral walls of the pharynx. Posteriorly, and on each side of the median line, the pharyngeal plate has seven sensillae (Plate XII, fig. 84 *sn*) which, gathering from their position, and from the thinness of the wall of the dome covering each sensilla are probably gustatory in function. Under the dome of each sensilla is an elongated sense cell in the centre of which there is a receptor (Plate XIII, fig. 93). Each group of seven sensillae is innervated by a nerve which can be traced to the suboesophageal ganglia. The epithelial cells under the plate are columnar and very well developed (Plate XII, fig. 83; Plate XIII, fig. 92). The epithelium in the dorsal wall of the pharynx is a syncytium (Plate XIII, fig. 92).

Just behind the entrance of the mouth the pharynx has six, presumably gustatory sensillae in its dorsal wall under the labrum (Plate IV, fig. 22 *sn*).

The *oesophagus* is very narrow and extends from inside the head to the end of the thorax, and in the abdomen it enlarges into the crop. Leaving the head to the thorax, the oesophagus passes through the partition of the occipital foramen which lies dorsal to the transverse tentorial body.

Structurally the oesophagus is composed of an innermost layer of chitinous intima lining, a syncytial layer which is thrown into folds and which rests on a basement membrane. The muscular coat is composed of an inner longitudinal layer and an outer circular one (Plate XII, fig. 85).

The *crop* is a much dilated prolongation of the oesophagus. Its walls are thrown into numerous folds (Plate XII, figs. 88 and 89) showing its great capacity for extension. The crop lies in the anterior part of the abdomen and its structure is the same as that of the oesophagus, except that its muscles are comparatively poorly developed. At its posterior end the crop

is invaginated by an inpushing of the anterior end of the proventriculus which projects a little distance into the cavity of the crop (Plate XII, fig. 86).

The *proventriculus* is a short narrow region of the gut joining the crop to the ventriculus (Plate XII, fig. 88). Its posterior end projects into the mid-gut forming what is generally known as the cardiac or oesophageal valve (Plate XII, fig. 86; Plate XIV, fig. 100). Wigglesworth (1930) showed that this structure does not act as a valve but as a sphincter and hence, he thinks that, the term « valve » is unfortunate. Into the lumen of the proventriculus project three longitudinal folds, the intima of which is strongly chitinised and provided with denticles (Plate XII, fig. 87). This strong chitinisation is prominent in the anterior half of the proventriculus and is lost posteriorly (Plate XII, fig. 86). Three comparatively very small folds alternate between the prominent ones; their chitinous lining is not thickened. It seems that the number of the prominent folds of the proventriculus is different in different families of Hymenoptera. In both *Apis mellifica* L. (Pavlovsky and Zarin, 1922) and *Vespa vulgaris* L. (Green, 1931) they are four; eight in *Camponotus* (*Formica*) (Wheeler, 1910) and three in *Harmolita* (Chalcidae) (James, 1926).

Structurally the proventriculus is composed of an innermost layer of well developed chitinous intima, outside which is a layer of epithelial cells lying on a basement membrane, followed by a coat of three layers of muscles, an inner longitudinal, a middle circular, and an outer longitudinal. The cells of the epithelial layer are well marked anteriorly but in the posterior part of the proventriculus their limit is very difficult to make out. The layers of the inner longitudinal muscles are well developed in the longitudinal folds (Plate XII, fig. 87) and on the whole are stronger anteriorly than they are posteriorly.

The *cardiac invagination* (6) is short and does not extend far in the mid-gut as it usually does in most other insects. Its inner wall (Plate XIV, fig. 100) is a continuation of the chitinous intima and the epithelial layers of the proventriculus. These two layers are reflexed upwards to form the lower part of the outer wall. The upper part of the outer wall is composed of a syncytium which takes the stain deeply (Mallory's phospho-molybdic triple stain) and which is apparently not a continuation of the proventricular layers. At the bottom of the invagination there is a blood sinus (Plate XIV, fig. 100 *bs*) which when full distends the invagination (Plate XIV, fig. 100) and when empty turns it flabby or collapsed (Plate XII, fig. 86). Just where the invagination dips into the mid-gut there is a layer of sphincter muscles

(6) « Invagination » is used here in place of the word « valve ».

(Plate XIV, fig. 100 *sph*) which in fact is a development from the middle circular muscles of the proventriculus.

The *ventriculus*, mid-intestine, or true stomach is here a cylindrical tube of comparatively wide diameter, beginning at the cardiac invagination and ending at the opening of the malpighian tubules. Externally, it bears very slight annulation which disappears in well fed insects. This annulation is prominent in other insects, and Shinoda (1927) thinks that it is dependent on the amount of food in the stomach.

Histologically the *mid-gut* consists of an enteric epithelium lying upon a basement membrane, outside the latter are an inner circular and an outer longitudinal muscles (Plate XIII, fig. 95).

The *epithelium* is composed of a layer of large cubical cells with round nuclei. Towards the inside, these cells have a well marked striated hem, due to closely set cilia-like structures which stain deeper than the cells in Delafield's, and which stain grey in iron alum haematoxylin. This hem is often seen pealed off or delaminated into the lumen to form the periotrophic membrane, and during the active phase it is, of course, missing. In few instances a globule may be seen as though on point of liberation from the cell into the lumen; Pavlovsky and Zarin (1922) described these globules as artificial.

Very few nidi or regenerating cells, peculiar to adult insects, are found in the mid-gut epithelium of *Microbracon hebetor* Say (Plate XIII, fig. 94).

At the entrance of the mid-gut there are some cells which stain deeply (Plate XIV, fig. 100). It has been shown (Wigglesworth, 1930) that these cells are, in some insects solely, and in others partly, responsible for the secretion of the periotrophic membrane. While it is not absolutely clear whether these cells take any part in the formation of the periotrophic membrane in this insect, and if so, to what extent, it is certain that the delamination of the striated hem plays an important role in the formation of that membrane.

Hind-gut

The hind-gut begins at the opening of the malpighian tubules and ends at the anus (Plate XII, fig. 88). It is about the same length as the mid-gut and, externally, can be differentiated into four regions:

(1) A short region just posterior to the opening of the malpighian tubules; the diameter of this short transitional region is a little less than the posterior end of the mid-gut.

(2) A comparatively long region which is narrower than the first, and ends before the dilation of the rectum.

(3) A much dilated part the diameter of which is the greatest in hind-

gut, this region contains, in its anterior part, the so-called « rectal glands » or pads.

(4) A short narrow passage leading to the anus.

Histologically these four regions though essentially the same, differ in details. The first region is composed of a cuticular intima, an epithelial layer sitting on a basement membrane, outside which are inner circular and outer longitudinal muscles. The cuticular intima and epithelial layers here are not thrown into folds. The epithelial cells are flat with oval nuclei (Plate XIII, fig. 95). Both circular and longitudinal muscles are comparatively well developed. In the second region both the cuticular and epithelial layers are thrown into many folds. The epithelial cells are vestigial and the longitudinal muscles are wanting in this region. In the third region, the epithelial cells are very poorly developed especially where the rectal glands are; the cuticular intima is well developed and both epithelium and intima are thrown into folds in the regions where the glands are absent; longitudinal muscles are wanting and circular are poor. In the fourth region the intima and epithelium are very much thrown into folds resembling those in the oesophagus (Plate XIII, fig. 99), the longitudinal muscles are absent, the circular muscles are very well developed forming a powerful sphincter. This part of the gut is suspended from the dorsal and lateral walls of the body by numerous muscles (Plate XIII, fig. 99).

The *rectal glands* or pads are four in number and are evenly spaced on the walls of the anterior part of the rectum (Plate XIII, fig. 96). In *Apidae* and *Vespidae* they are six in number, in *Formica* they are three (Wheeler, 1910) and in *Harmolita* (Chalcidae) they are only two (James, 1926). In *Microbracon* the glands or pads are not elongated as they are in most other insects, but are cubical. Each pad has an axial cavity (Plate XIII, fig. 97 *axc*), which divides it into an exterior and an interior layer of cells separated laterally by a syncytial which stains deeply (iron alum) (Plate XIII, fig. 97 *syn*). The exterior layer is composed of two rows of small spherical cells which generally stain deeper than the interior. The interior layer is composed of only one row of comparatively very elongated cells with big nuclei poor in chromatin. Invariably these cells of the inner layer have inclusions which stain deeper (Plate XIII, fig. 98 *ci*). Each pad is richly supplied with trachea, branches of which penetrate the exterior layer (Plate XIII, fig. 98) and ramify intercellularly in the inner layer. The inner cutical intima lining the pads is of course continuous on the whole inner surface of the rectum, but on the pads it is more developed. The function of these pads was at first thought to be secretive, but Wigglesworth (1932) suggests that it is absorbtive and that these pads reabsorb water from the excrements before this is discharged, and thus play an important part in water-conservation.

The *malpighian tubules* are twelve to fourteen in number; each tubule opening separately into the gut and all open at one level round the junction of the mid and hind-guts. They are long, filamentous, greenish tubules intermingled together, and coiled about the abdominal viscera (Place XII, fig. 88). In cross-section each shows a single layer of four or five large cubical cells with big round nuclei (Plate XII, fig. 91). This epithelium is internally lined with very thin cuticular intima, and externally bordered on a basement membrane outside which there are no muscles. The lumen is longitudinally irregular (Plate XII, fig. 90). The tubules and the gut are in open communication and where they join (Plate XIII, fig. 95) the longitudinal and circular muscles on the gut and on the neck of the tubules are well developed and probably responsible for the vermiform movement of the tubules. In *Doryctes gallicus* Reinh. (Braconid), Seurat (1899) found only 9 tubules.

Salivary glands

Bordas (1894, 1894a and 1895) described ten different kinds of so called salivary glands in Hymenoptera. Seurat (1899) described two kinds in *Doryctes gallicus* Reinh. (*Braconidae*), the thoracic salivary glands, and another pair of glands which « are like a bunch of grapes and which occupy the posterior dorsal region of the head behind the brain and open in the oesophagus ». He did not figure or describe their exact opening in the oesophagus.

In *Microbracon hebetor* Say, the present investigator was able to find only the thoracic pair of salivary glands. It seems probable that Seurat mistook the masses of fat cells, usually found behind the brain, for salivary glands, a misinterpretation which both Bordas (1895) and Snodgrass (1910) did in the case of the honey-bee; closer inspection, however, made Snodgrass (1925) correct himself.

The two thoracic glands of *Microbracon hebetor* Say are not very well developed and are situated in the anterior part of the mesothorax under the median indirect wing muscles. The two ducts from the glands meet just before entering the head and form one prominent duct which runs under the oesophagus and pharynx and opens at the dorsal side of the labium ventral to the hypopharynx (Plate XII, fig. 83).

Circulatory system

Seurat (1899) does not describe the circulation system of *Doryctes*. In *Microbracon hebetor* Say, the blood has a very faint yellowish tinge and contains few granular leucocytes. There is a dorsal or pericardial diaphragm and a dorsal vessel. No ventral diaphragm was found.

The *dorsal diaphragm* extends from the anterior region of the seventh

to the anterior part of the third abdominal tergum, separating a dorsal or pericardial sinus from the rest of the haemocoele. Radiating in the diaphragm are five pairs of alary muscles each of which converge to a small area of attachment on the tergum. Medially, fine fibres from branches of these muscles are attached to the ventral side of the heart (Plate XIV, fig. 106 *fb*). Comparatively few of these fibres extend under the heart.

The *dorsal vessel* extends from the anterior region of the seventh abdominal tergum to the head, where it bifurcates just under the deutocerebrum, giving off a branch to each antenna.

In the abdomen, the dorsal vessel is situated in the pericardial sinus, just under the integument, from which it is suspended by several suspensoria (Plate XIV, fig. 106 *us*). These suspensoria are exactly similar to the fine fibres of the alary muscles attached to the ventral side of the heart. In the second abdominal segment, the dorsal vessel dips down and becomes twisted into three or four convolutions before entering the alitrunk. In the alitrunck it is very much narrower in calibre and runs dorsal to the alimentary canal and ventral to the median indirect muscles (Plate VIII, fig. 55 *ao*). It enters the head through the dorsal partition of the occipital foramen. The part of the dorsal vessel extending from the seventh to the second abdominal terga is the pulsating organ or heart. The remaining part of the dorsal vessel beginning after the convolutions is the conducting part or aorta.

The heart is composed of five chambers, in each chamber there is a pair of ostia. At each ostia, the walls of the heart are prolonged inwards and forwards into the lumen forming the valves. The ostia and valves are best seen if a testaceous living specimen of *Microbracon hebetor* Say is mounted in normal saline solution and one of the heart chambers is watched under high magnification with the help of a powerful transmitted « pointolite ».

On either side of the heart are situated the dorsal nephrocytes or pericardial cells (Plate XIV, fig. 106 *prc*) held in their position relative to the heart by thin fibres. The generally accepted view is that the nephrocytes are excretory in function.

Central nervous system

The two cephalic centres of the nervous system, the brain and the suboesophageal ganglia, form one mass in this insect. In most adult Hymenoptera, the para-oesophageal connectives are described as short and robust; in this insect, all external identity of these connectives is lost; internally their traces can still be recognised in sections. Through the centre of this concentrated mass passes the alimentary canal.

Of the three primitive regions of the brain, the proto-cerebrum and

deuto-cerebrum are well marked. The treto-cerebrum is very difficult to make out and can only be marked by the origin of the two nerves going forward to the frontal ganglion of the visceral nervous system.

The proto-cerebrum, which forms most of the bulk of the brain, innervates the compound eyes and the ocelli. At its centre lies the central body (Plate III, fig. 19) with its superior and inferior capsules clearly marked (Plate III, fig. 19 *sus* and *ic*). The central body is flanked on each side by the prominent optic lobes which are clearly differentiated into the inner medullary mass (opticon) (Plate XIV, fig. 102 *opt*), the middle medullary mass (epiopticon) (Plate XIV, fig. 102 *epo*) and the outer medullary mass (periopticon) (Plate XIV, fig. 102 *po*). Ventral to the inferior capsule of the central body originate the two peduncles of the corpora pedunculata or mushroom bodies (Plate III, fig. 19 *pdc*). Each peduncle curves outward and then splits into two branches forming one stalk. Each branch runs upwards close to the other, and, near the dorsal periphery of the proto-cerebral lobes, it carries a calyx (Plate III, fig. 19 *c*). The calyces are buried in the proto-cerebral lobes and do not show particular external dorsal bulging as they do in the case of bees, wasps and ants. Each calyx in *Microbracon hebetor* Say shows signs of splitting into two separate calyces, an upper and a lower one; thus in this respect they show a complexity which is worthy of consideration, since mushroom bodies are compared to the cerebrum of vertebrata and are regarded by many authors as the motor and psychic centres of the brain. This complexity is an index of the degree of reflex and psychic behaviour.

From the dorso-median region of the proto-cerebrum arise the three nerves innervating the ocelli, the median nerve is of double origin.

The simple and compound eyes are of the usual insect type which has been described by many authors and will not be further described here.

The deuto-cerebrum is composed of the two antennary or olfactory lobes and is situated antero-ventral to the proto-cerebrum. Each olfactory lobe consists of a central fibrous portion containing, peripherally, round bodies of more closely set fibres. These round bodies are sometimes referred to as glomeruli from their resemblance to the well-known structures in vertebrate olfactory lobes. The deeply-staining ganglionic cells forming the cortex of the olfactory lobes are larger than those forming the rest of the cortex of the brain. The deuto-cerebrum innervates the antennae.

Ventral nerve cord

The sub-oesophageal ganglion still shows its treble origin from the three primitive neuromeres (Plate XII, fig. 83). At its posterior end, it sends backwards, to the thorax and abdomen, the rest of the ventral nerve cord.

In leaving the head, the ventral nerve cord passes through the ventral partition of the occipital foramen. The connectives between the ganglia of the ventral nerve cord are double. In *Harmolita* (*Chalcidae*), James (1926) describes these connectives as single, a state which he regards to be more advanced than the usual and more generalised double cord found in most insects.

In the thorax, the ventral nerve cord has two main centres. The anterior centre is the prothoracic ganglion which lies in front of and resting on the profurca. It innervates the prothoracic pair of legs. The second main thoracic centre of the nerve cord, lies in the region formed by the posterior part of the mesothorax and the anterior part of the metathorax. This ganglionic mass in unquestionably composed of the coalesced meso and metathoracic ganglia. The coalescence is not entire, and the identity of the meso and metathoracic ganglia can easily be observed. In a sagittal section, the posterior part of the metathoracic ganglion shows two faint constrictions, denoting that this ganglion is a compound one, composed of three ganglia. Thus the whole ganglionic mass is really composed of four ganglia, and belongs to the mesothoracic, metathoracic, first abdominal and second abdominal segments, because it innervates the meso and metathoracic wings and legs and their muscles, as well as the muscles of the first and second abdominal segments.

Just at the anterior end of the mesosternum, there is a comparatively small extra thoracic ganglia, which is apparently of a secondary development, and which sends small nerves to the median indirect wing muscles.

The number of nerve centres in the gaster of many Hymenoptera differs in different sexes (Imms, 1925, p. 537; James, 1926; Grandi, 1929). In *Doryctes* (*Braconidae*), Seurat describes four centres in the male and three in female. In *Microbracon hebetor* Say the apparent number of nerve centres in the gaster of both male and female is four. But in longitudinal sections the last nerve centre of the male shows two constrictions, while that of the female shows only one (Plate XIV, fig. 101), a fact denoting that this centre is composed of one more ganglion in the male than it is in the female, and that there is really no great morphological difference between *Doryctes* and *Microbracon* in this respect.

The first abdominal ganglionic centre is situated just after the propodeum, the second is situated at the posterior end of the third segment, the third at the posterior end of fourth segment and the last occupies the fifth and sixth segments.

It is interesting to note that, it the female, the ventral nerve cord passes between the oviducts, beneath the alimentary canal, and that the last ganglionic mass is closely appressed to the dorsal region of the vagina, just above

the spermatheca; while in the male, the last ganglionic mass is situated dorsal to the anterior part of the combined mucous gland, and that the nerve cord does not pass between the two vasa deferentia.

Respiratory system

The respiratory system consists of the tracheal system and the spiracles. The tracheal system in this insect contains no air sacs. Seurat (1899) describes in details the tracheal system of *Doryctes gallicus* Reinh. (*Braconidae*) and compares it with that of *Microplitis seurati* Marshall (*Braconidae, Microgasteridae*). The tracheal system of *Microbracon hebetor* Say agrees with Seurat's description of that of *Doryctes*, for this reason, its description is not included in this paper, and only the spiracles are described, since Seurat did not describe the spiracles of any species studied by him.

The number of spiracles is ten pairs, three pairs are situated in the alitrunk and seven in the gaster. Morphologically, the two most anterior pairs of the alitrunk are the true thoracic, the third pair belongs to the abdomen and was shifted to the thorax with the first abdominal tergum forming the propodeum in this insect. This last pair resembles the abdominal spiracles in every detail and is essentially different from the true thoracic spiracle.

The first thoracic spiracle is situated in front of the anterior lower corner of the tegula, hidden under the lateral posterior corner of the pronotum, in a sort of membranous pocket. Externally it cannot be detected, and the best way of finding it, is carefully to dissect the pronotum and to examine it from the inside, the spiracles will be found near the edge (Plate VI, fig. 44 *sp*).

The second thoracic spiracle is situated between the meso and metapleura (Plate VI, fig. 40 *sp*), and owing to its minuteness it is usually difficult to find.

The remaining eight pairs of spiracles are all of the same structure and nearly the same size, and are situated segmentally at the lateral edge of the first morphological eight abdominal terga (Plate VI, fig. 40; Plate X, figs. 70 and 73; Plate XI, figs. 76 and 77).

Owing to the extreme minuteness of the two thoracic spiracles all attempts to work out their structure and mechanism with the available magnification were unsuccessful.

Each abdominal spiracle can be detected by its dark circular peritreme (Plate XIV, fig. 103 *per*). Externally the spiracle is exposed on the surface of the tergum and is not situated in a pocket or invagination; furthermore, it is not protected by hairs or spines (Plate XIV, fig. 103). The external spiracular opening is circular and has a diameter of 7-8 μμ. It is situated in the centre of the circular peritreme. The chitinous covering from the

edges of the peritreme to the spiracular opening is thin and slightly coloured, a case which in many instances adds to the difficulty of finding the minute spiracular opening.

The spiracular opening leads to an outer chamber (Plate XIV, fig. 105). In many insects the inner surface of the walls of this chamber is covered by hairs or spines, in this insect, it is devoid of these structures, but is somewhat rough. At the bottom of this chamber there is a circular opening which leads to a shallow inner chamber (Plate XIV, fig. 105 *och*). This inner chamber corresponds to the *chambre de fermeture* of Janet (1902). The inner chamber immediately leads to two hollow chitinous structures (Plate XIV, fig. 104 *bo* and *lv*). One of these structures (Plate XIV, fig. 104 *bo*) is stationary and has its tip pointing towards the head; it gives attachment to the closing muscles, and in this connection it might correspond to the bow of some other insects. The other chitinous structure (Plate XIV, fig. 104 *lv*) is the lever, which is movable on its basis. Before the entrance to the lever there is a chitinous piece (Plate XIV, figs. 104 *cp* and 105 *cp*) which projects inwards, and at the entrance to the lever is the opening of the trachea.

When the closing muscles *om* (Plate XIV, fig. 104) contract *B* (Plate XIV, figs. 104 and 105), the lever is raised up and the opening of the trachea is brought against the chitinous piece (Plate XIV, figs. 105 *cp* and 105 *cp*) and is thus closed. When the opening muscles (Plate XIV, fig. 104 *opm*) pulls down the lever, the opening of the trachea is brought away from the chitinous piece and is thus put in communication with the inner and outer chambers (Plate XIV, figs. 104*A* and 105*A*).

The spiracle is richly supplied with nerves and trachea which ramify round the whole apparatus.

The best way of studying how the spiracle works, is to mount a living specimen in either glycerine or normal saline solution and to watch the last abdominal spiracle (this is chosen because the scleritisation is faint around it and one can see through better than in the case of other spiracles) under high magnification, with the help of a powerful « pointolite ».

Reproductive system

Male reproductive organs

Bordas (1894a) studied the male reproductive organs in representatives of several Hymenopterous families, but no Braconid example was included in his work. In *Microbracon hebetor* Say, the male reproductive organs consists of: (1) a pair of testes, (2) a pair of vasa deferentia which empty into (3) a combined pair of accessory or mucous glands leading to (4) a single short ejaculatory duct. There are no special vesiculae seminales.

The *testes* lie under the fifth and sixth abdominal terga, dorsal to, and resting on the alimentary canal (Plate XV, fig. 110). They are pear-shaped and have a strong yellow colour. In most individuals the two testes are medially connected together by a thin scrotum; in rare cases, some males have their testes separate.

Histologically, the wall of each testis is composed of an inner layer of degenerate epithelial cells which stain deeper (Heidenhain iron haematoxylon and Delafield's) than other layers. This layer of degenerate cells sits on a basement membrane outside which is a prominent coat of peritoneal connective tissue. Henschen (1928) showed that the rosette-shaped arrangement or cysts found during development in the testes and ovaries of the honey bee and other Hymenoptera are found in this insect only in the testes and not in the ovaries.

The *vasa deferentia* form a loop through which the alimentary canal passes (Plate XV, fig. 110). Histologically each vas deferens consists of an innermost layer of elongate glandular epithelial bordered by a basement membrane, to the outside of which are two layers of muscles, an inner circular, and an outer longitudinal. Covering the muscle layers is a well developed coat of peritoneal connective tissue.

Posteriorly, and just before entering the mucous-glands, the two vasa deferentia run close to one another and in this short region their peritoneal coverings become fused and form a common coat investing the two vasa. They then meet the mucous glands and the four canals become invested in a common coat of peritoneal connective tissue (Plate XV, fig. 108). Ultimately, eah vas deferens opens into the dorsal wall of the mucous canal of its side (Plate XV, fig. 109).

The *mucous* or *accessory glands* of this insect are not separate as they usually are in many other Hymenoptera (*Apis, Bombus, Vespa, Harmolita, Blastophaga* (last two are *Chalcididae*) and *Ophion* (*Ichneumonidae*). They are, in this insect, composed of two well developed tubular glands invested with a common coat of peritoneal connective tissue throughout their length, so that externally they appear single (Plate XV, fig. 110 and 112). They lie in the median ventral line of the abdominal cavity, and on the dorsal side of their anterior end lies the last abdominal ganglion. The two externally bound, but internally separate glands run backwards to open separately into the common ejaculatory duct, a short distance anterior to the exterior opening of the penis. It is interesting to note that in *Doryctes gallicus* Reinh. (*Braconidae*), Seurat (1899) does not describe any such glands; whether they are there and escaped his notice or whether they are really absent, the present investigator cannot exactly tell. If it were the second case and they are really absent, it is worth noticing that this morphological difference occurs in such closely related insects.

Where each vas deferens enters the gland of its side there is a lip or valve (Plate XV, fig. 109 *v*) which apparently closes the opening of the vas deferens when the secretion of the mucous gland travels backwards towards the ejaculatory duct.

Histologically the accessory glands are exactly similar to the vasa deferentia (Plate XV, fig. 107). The only structural difference between the vasa deferentia and the accessory glands is that the glandular epithelium of the accessory or mucous glands is composed of cells which are longer and more active in secretion than the corresponding cells of the vasa deferentia. According to Bishop (1920), in the honey bee there is a third innermost layer of longitudinal muscles extending from the base of each gland more than half way to its anterior end. This muscular layer is missing in the case of *Microbracon hebetor* Say and only two layers are found, an inner circular and an outer longitudinal which are a continuation of the two layers of the vasa deferentia.

The glandular epithelium of the vasa deferentia and of the mucous glands, early in the life of the male, undergoes an erosive process after which only the basal remnants of these cells are left (Plate XV, fig. 109).

The *ejaculatory duct* is a single very short canal. Its wall is composed of a layer of small cubic epithelial cells internally lined with chitinous intima. There are two layers of muscles, an inner circular, and an outer longitudinal which are a continuation of the muscle layers of the mucous glands. The coat of the peritoneal connective tissue covering the testes, the vasa deferentia, and the accessory glands, does not extend over the ejaculatory duct.

Male genitalia

At present there is no agreement on the terminology used for the male genitalia of Hymenoptera. Zander (1900) and Boulangé (1924) tabulate the greatly involved synonymy of these parts. In this paper, however, Zander's nomenclature is adopted.

The genitalia of *Microbracon hebetor* Say are situated between the morphological ninth and tenth sterna, and consist of the following parts:

(1) A basal ring-like piece (Plate XV, fig. 111 *bp*) which has a large triangular ventral surface, and a narrow dorsal one. The dorsal surface is feebly scleritised and is attached to the membrane between the ninth and tenth sterna. The ventral surface is thickly scleritised at its anterior part, but its posterior part is membranous, presumably to give the rest of the genitalia free movement.

(2) Articulated to the basal piece, and embracing the other parts of the genitalia, are the two external valves (Plate XV, figs. 111 *exv*, 112 *exv* and 113 *exv*) or claspers, one on each side of the median line. Distally, each

external valve bears a group of long tactile sensory hairs. On their outer side the external valves are scleritised, but on their inner side they are membranous (Plate XV, fig. 113). Ventrally the two external valves do not meet medially (Plate XV, fig. 111), but dorsally they meet above the penis for a short distance (Plate XV, fig. 112).

(3) Articulated to the ventral base of each of the external valves, and in many cases attached to it by a narrow neck, is the internal valve (Plate XV, figs. 110 *inv*, 111 *inv*, 112 *inv* and 113 *inv*), which is concave and scleritised on its ventral side (Plate XV, fig. 113). On its distal end each internal valve, or volcella of some authors, bears a versatile process (Plate XV, figs. 110 *invp*, 111 *invp* and 112 *invp*). This process bears numerous sensillae (Plate XV, fig. 111 *sn*), and moves very actively when the male is about to copulate.

(4) The penis is relatively large and is situated medially dorsal to the inner valves (Plate XV, figs. 111 *p*, 112 *p* and 113 *p*). Ventrally the penis has an elongated keel (Plate XV, figs. 111 *pk* and 113 *pk*). On each side of the keel, the ventral wall of the penis has a longitudinal well scleritised ridge (Plate XV, figs. 111 *sz* and 113 *sz*) which gives attachment to the longitudinal muscles of the organ. Zander (1900) says that these two ridges indicate the double origin of the penis. The genital opening is situated at the tip of the penis, somewhat to the ventral side (Plate XV, fig. 110 *po*). Ventrally, and at its posterior end, the penis bears numerous sensillae, shown as dark spots in Plate XV, figure 111.

Running in the basal cavity of the genitalia are two strong chitinous struts (Plate XV, fig. 111 *chs*) which give attachment to the well developed longitudinal muscles of the internal and external valves. The anterior ends of these struts are free in the basal cavity of the genitalia; their posterior ends are not so strong, and are embedded at the bases of the processes of the inner valves.

What is here termed the penis correspond to a part of the true aedeagus of other insects formed of the penis and parameres. The internal valves are the parameres. The external valves are the coxites of the ninth segment. With regard to the basal piece, Singh Pruthi (1924) writes « No account of the development of this region is available, but from the position of the cardo (basal piece), between the ninth sternum and its coxites, it appears that Zander was correct in considering this piece to be a part of the ninth ternum ». It appears that Singh Pruthi overlooked Zander's account of the development of this piece in *Vespa germanica* L.. Zander (1900) showed that the basal piece (cardo) develops as a single pad from the ventral and lateral base of the rudimentary genital buds. This will eliminate the idea that the basal piece is a part of ninth sternum: it is categorically a part of the genitalia, and its homology is, at present, not clear.

Female reproductive organs

The female reproductive organs lie entirely in the abdomen. They consist of a pair of ovaries situated one to the left, the other to the right of the alimentary canal. Each ovary consists of two ovarioles (Plate XVI, fig. 114) which, at their posterior end, empty into a very short oviduct (Plate XVI, fig. 114 *ovd*). The two oviducts run obliquely and ventrally to unite in the median line forming the common oviduct followed by the vagina (Plate XVI, fig. 114 *va*), which runs medially, ventral to the alimentary canal, and then opens between the eighth and ninth sterna. The spermatheca is situated in the dorsal anterior region of the vagina (Plate XVI, fig. 114 *spm*). In *Doryctes*, Seurat (1899) describes a colletrial gland, which is spherical in form and acinous in structure, and which opens medially behind the spermatheca. In *Microbracon hebetor* Say, the present investigator did not find any colletrial glands.

The *ovarioles* present remarkable variation in size according to season and nutrition. In winter, and when the insect does not feed on nitrogenous food, the ovarioles are very short, barely half a millimetre in length, and contain no eggs or oocytes. When the warm weather sets in, and the insect feeds on its usual nitrogenous diet, the ovarioles are greatly enlarged. The average length of each ovariole is then 5 mms. As the abdomen is only 1.8 mm. in length, the ovarioles are consequently folded on themselves (Plate XVI, fig. 114) and nearly fill the whole abdominal cavity squeezing the other organs. They are then full of oocytes and eggs.

At its posterior end, each ovariole is distended to form a calyx or reservoir (Plate XVI, fig. 114 *cx*), in which the mature eggs are stored until they are laid. In most insects the calyces are formed in the oviducts and not in the ovarioles. *Chalcididae* agree with *Braconidae* in having the calyces in the ovarioles and both differ from *Ichneumonidae* in which the calyces are formed in the oviducts.

The ovarian wall is very thin, less than 2 μμ, and is composed of small epithelial cells, to the outside of which is a layer of tunica propria. According to Henschen (1928) these epithelial cells are more developed in the pupa than they are in the adult.

Four regions can be distinguished in each ovariole:

(1) An apical region containing a syncytium of elongated nuclei. This region is of a very narrow calibre.

(2) A region which contains small cells of similar size and cytology. This is the end chamber or *germarium*. Regions (1) and (2) occupy a short terminal part (Plate XVI, fig. 114 *tf*).

(3) A region where nutritive cells alternate with the developing ova. This region is the *vitellarium* and is the longest of all regions (Plate XVI,

fig. 114 *vt*). Since there are nutritive cells in the ovariole it is thus of the type known as *meroistic;* and since the nutritive cells alternate with the oocytes in the vitellarium (Plate XVI, fig. 115), the ovarioles are of the type recognized as polytrophic which is common in Hymenoptera.

(4) A region marked by the presence of mature or almost mature ova, and by the absence of nutritive cells and follicular epithelium.

There is no ovarian ligament in this insect. Each two ovarioles of one side are terminally connected together by a short thin yellow tissue which is easily torn off in the dissection. The ovarioles thus end freely in the body cavity. In *Chalcididae* (Baird, 1921, and James, 1926), the ovarioles generally adhere to one another longitudinally, but can easily be separated In *Microbracon hebetor* Say and other *Braconidea* they are longitudinally free

Each *oviduct* is a distendable short tube constituted of a thin internal epithelial layer with a basement membrane and an outer coat of circular muscles. The two oviducts unite to form a common oviduct which is very short and lies at the anterior of the vagina.

The *vagina* is a short comparatively wide tube. It is internally lined with a thin cuticular layer and has an external coat of circular muscles. At its anterior dorsal region is situated the opening of the spermathecal or seminal duct. It gives attachment to numerous muscles which originate on the eighth sternum and pleura; these muscles presumably help in oviposition.

The *spermatheca* is small and absolutely spherical. According to Seurat (1899) it is cylindrical in *Doryctes gallicus* Reinh.. In *Microbracon hebetor* Say it has a well scleritized and relatively thick chitinous intima, which is strongly testaceous in colour. The diameter of the spermathecal lumen is 25 μμ and the thickness of the wall is 6 μμ. Outside the chitinous intima, there is one layer of prominent epithelial cells bordered by a basement membrane, outside which is a coat of muscles. There are two spermathecal glands which are short and tubular, and which open by a short common duct into the anterior dorsal region of the spermatheca. The spermatheca, in its turn, opens into the vagina by a short seminal duct.

Female genitalia

The female genitalia are modified to serve both for oviposition and for piercing. They lie in the eighth and ninth abdominal sterna, which are invaginated to form the genital chamber. But the posterior part of the genitalia always projects beyond the abdomen (Plate X, fig. 70). The female genitalia consist of the following parts.

(1) The quadrate or outer plates (Plate XI, fig. 76 *qp*) which are, in fact, lateral prolongation of the ninth tergum (Plate XI, figs. 76 and 77). In some Hymenoptera, the dorsal part of the ninth tergum is either missing or mem-

branous. This fact led Berlese (1909) to regard the quadrate plates as parts of the eighth sternum since, in repose, they lie ventrally and are overlapped by the eighth tergum. However, evidence from developmental history and comparative anatomy leaves no doubt now that the quadrate plates are parts of the ninth abdominal tergum.

Running along the length of each quadrate plate are two scleritised ribs, a faint middle one (Plate XI, fig. 78 *qr*) and a comparatively strong lateral one (Plate XVI, fig. 118 *qrs*). The lateral rib gives attachment to muscles from the inner plate (Plate XVI, fig. 118 *op*).

The quadrate plate articulates to a triangular or fulcral plate (Plate XI, figs. 76 *tp* and 78 *tp;* Plate XVI, fig. 118) and overlaps the oblong or inner plate (Plate XVI, fig. 118 *op*).

(2) The triangular or fulcral plate (Plate XI, fig. 76 *tp*) articulates by one of its three corners to the quadrate plate as was already mentioned, by the second corner it articulates with the inner plate, and by the third corner it articulates with the diverging arm of the stylet (Plate XVI, fig. 118). Moreover it is attached by muscles to all these parts and thus plays an important role in the movements of the apparatus. Morphologically it is a part of the eighth sternum as was shown by Zander (1899) in the honey-bee.

(3) The inner or oblong plates (Plate XI, fig. 76 *op*) are situated to the inside of the quadrate plates. At its basis each oblong plate enlarges into a lamina which articulates with the diverging arm of the stylet sheath (Plate XVI, fig. 118). In the inner side of the oblong plate there is a short, heavily scleritised rib (Plate XI, fig. 78 *or;* Plate XVI, fig. 118 *or*), and on its outer edge is another longer and stronger rib, which has its origin at the articulation with the fulcral plate (Plate XI, fig. 78 *n;* Plate XVI, fig. 118 *ors*). Both ribs give attachment to muscles. At its articulation with the fulcral plate, the inner plate is curved inwards and carries numerous sensillae (Plate XI, fig. 78 *sn;* Plate XVI, fig. 118 *sn*).

Posteriorly the oblong or inner plate is elongated into a palp-like process (Plate XI, figs. 76 *gd* and 78 *gd*), which is clothed on its outer side with long sensory hairs, its inner side is devoid of these hairs (Plate XI, fig. 80). The anterior part of the palp-like process is thrown into numerous folds to allow bending; the the posterior part is enlarged into a club-shaped end, and is devoid of folds (Plate XI, fig. 80). The inner side of the process has a longitudinal groove which runs along its entire length; when this groove is applied to the groove of the other palp-like process a tube is formed. In this tube the interlocked stylets and stylet sheath are lodged when the genitalia is not in action. The groove becomes finer at the posterior tip of each palp-like process (Plate XI, fig. 80); it is with these tips that the stylet and stylet sheath are guided by the palp-like processes in piercing the victim, and the

fineness of the grooves at this part ensures accurate holding. Each palp-like process is innervated by a nerve (Plate X, fig. 82 *nv*) and supplied by a trachea (Plate XI, fig. 82 *tr*).

In *Blastothrix* (*Chalcidae*), Imms (1918) found a joint between the inner plate and the palp-like process; there is no corresponding joint in *Microbracon hebetor* Say. Seurat (1899) is not clear on this point in *Doryctes*.

Morphologically the oblong or inner plate is a part of the ninth sternum, and the palp-like process is a development of the ninth sternum.

(4) The stylet sheath is a long median piece apparently formed of two longitudinal pieces united along the middle line (Plate XI, fig. 82 *sh*). Along its ventral side the stylet sheath has two guide rails which neatly fit into corresponding stylet grooves. At its basis the stylet sheath enlarges to form a bulb (Plate XI, fig. 78 *shb*) which receives the secretions of the acid and alkaline glands. On its latero-ventral surface the bulb of the sheath has several sensillae (Plate XI, fig. 78 *sn*).

The bulb is formed by the bulging out of the dorsal and lateral walls of the sheath. The middle wall (Plate XI, fig. 82 *d*) disappears and one large cavity is formed (Plate XVI, fig. 119). On the disappearance of the middle wall (Plate XI, fig. 82 *d*) the ventral wall of the bulb becomes membranous at its middle line.

Towards the anterior of the bulb each side of the ventral wall branches into two. One outer branch which carries the guide rail, and an inner branch (Plate XVI, figs. 119 *dl* and 119 *dr*). Ultimately the outer branch diverges dorso-laterally with the stylet of its side and articulates with the lamina of the inner plate as was already mentioned. The inner branch (Plate XVI, fig. 119 *dl* or 119 *dr*) extends anteriorly in the ventral wall of the bulb until it ends.

The latero-dorsal walls of the sheath bulb are strengthened with two strongly scleritised ridges (Plate XVI, fig. 117 *sz* and 119 *sz*). The dorsal wall is relatively thin.

Anteriorly the bulb is drawn into a narrow blind end which is thickly scleritised (Plate XVI, fig. 117), and which gives attachments to muscles from the outer ribs of the oblong plates.

The posterior tip of the sheath has a dorsal keel (Plate XI, fig. 79). It bears no barbs or serrations, a fact which suggests that the sheath does not take part in forming the wound.

Morphologically the stylet sheath is a development of the anterior gonapophysis of the ninth sternum.

(5) The stylets (Plate XI, fig. 82 *st*) are separate throughout their entire length. In cross-section they are subtriangular and hollow (Plate XI,

fig. 82). They are of the same length as the stylet sheath and as the inner plate (Plate XI, fig. 78 *op*) together with its process (Plate XI, fig. 78 *gd*). Anteriorly each stylet diverges dorso-lateral from the median line and articulates with the fulcral plate of its side. At its posterior tip each stylet has five barbs on its lateral outer side (Plate XI, fig. 81 *b*) by which the wound is formed in the victim.

In *Doryctes*, Seurat (1899) writes that near the anterior region of the stylet sheath, each stylet bifurcates; one of the branches run forwards to articulate with the eighth sternum. There is no corresponding branch in the stylet of *Microbracon hebetor* Say; furthermore in the hymenopterous ovipositors described by Imms (1916 and 1918), James (1926) and Grandi (1929), and in the sting of the honey-bee the stylet is an unbranched process.

Morphologically the stylet is a development of the gonapophysis of the eighth sternum.

Thus the female genitalia of *Microbracon hebetor* Say are fundamentally composed, as in other insects, of three pairs of gonapophyses, and of the quadrate plate which is part of the ninth tergum, the fulcral plate which is part of eight sternum, and the oblong plate which is part of ninth sternum.

The glands of the sting

The glands of the sting consist of two systems: a simple alkaline gland, and a complex system of acid glands. The present investigator was unable to find the third or accessory poison glands described by Bordas (1897) in *Ichneumonidae*. The so-called « lubricating glands » described by Snodgrass (1925) in *Apis mellifica* L. are missing in this insect.

Alkaline gland

The alkaline gland is situated between the plates of the sting. It is an elongated transparent tube; and its external surface is somewhat folded and extremely fragile. Its posterior end is dilated (Plate XVII, fig. 121); and as the gland runs forward, it gets narrower, until it opens directly with a short neck 8-10 μμ in diameter into the anterior part of the stylet sheath bulb.

The wall of the alkaline gland is devoid of muscles, and consists of one layer of glandular epithelium bordered by a basement membrane to the outside, and internally lined by a chitinous intima. The epithelial cells are big, very distinct and polyhedral (Plate XVII, fig. 122). Their nuclei are round, and extremely poor in chromatin.

Acid glands

The acid glands form a well developed and unique apparatus, which is situated to the right of the median line of the abdomen, dorsal to the posterior end of the ovarioles of its side and consists of the following parts:

(1) A well developed oval reservoir devoid of any glandular elements (Plate XVII, fig. 120 *r*).

(2) A group of eight elongated turgid tubes, neatly arranged round the reservoir and held together in their position by a rich ramification of trachea (Plate XVII, fig. 121). These tubes are glandular, and open separately in a circle, at the posterior end of the reservoir, in a special vestibule (Plate XVII, fig. 125 *v*).

(3) A common glandular duct (Plate XVII, fig. 121 *cgd*), the lumen of which is only 4-5 μμ in diameter. This duct is comparatively long and enters the bulb of the stylet sheath on its left side (Plate XVI, fig. 116 *cgd*) and runs posteriorly for a short distance before it ends.

The reservoir is internally lined by a strong chitinous layer which, at regular intervals, is thickened into folds forming a well developed spiral (Plate XVII, fig. 125 *s*). This internal chitinous structure has a strong testaceous colour which, in dissecting, helps in finding the whole apparatus, otherwise difficult to find on account of its transparency and minuteness. Outside the chitinous layer of the reservoir, there is a zone of strong longitudinal muscles, which are inserted in bundles on the ridges of the spiral (Plate XVII, fig. 126). In *Dorycles*, Seurat (1899) describes a layer of inner circular muscles and an outer layer of longitudinal muscles on the reservoir. In *Microbracon hebetor* Say, there are no circular muscles (Plate XVII, fig. 127). The narrow posterior end of the reservoir is somewhat dilated into a vestibule into which the glandular tubes open by eight separate orifices. At its posterior end this vestibule leads to the common glandular duct.

The glandular tubes are not always of the same length or diameter but differ in different individuals and also in the same individual (Plate XVII, fig. 120). In many cases two or three of these tubes are of a size double that of the rest. Not infrequently, one or two tubes are bifid at their free end (Plate XVII, fig. 120). Each tube opens by a short narrow duct into the vestibule of the reservoir.

Histologically, the wall of each tube is composed of one layer of glandular epithelium lined with a thin chitinous intima and bordered by a basement membrane (Plate XVII, fig. 123). The epithelial cells are distinct, polyhedral and with big round nuclei which are very poor in chromatin. These cells are more active in their secretion than the glandular cells of the alkaline gland. The walls of the glandular tubes are devoid of muscles.

The common glandular duct is lined internally by a comparatively thick chitinous layer, outside which is a layer of columnar distinct cells covered with a thin membrane easily torn off (Plate XVII, fig. 124). Between the necks of the columnar cells are found numerous unicellular glands 2-3 μμ in diameter (Plate XVII, fig. 124 *ung*). Each gland opens separately into the lumen with a very short and narrow duct. Bordas (1897 and 1908), Janet (1898), Seurat (1899) and Pavlovski (1914) do not describe these minute unicellular glands; in the figure given by Genieys (1925) for *Microbracon brevicornis* Say poison apparatus, these glands are not shown, however, no description of the apparatus is given in his paper. Until the reaction of their separate secretion is known, one cannot speculate on the function of these unicellular glands. A short distance before entering the sheath bulb, the common glandular duct becomes devoid of its cells, and only a canal formed of the remaining inner thick chitinous lining enters the sheath bulb.

There is a great deal of variation in the form and structure of the acid glands and their reservoir among *Braconidae*. Seurat (1899) describes five different types, all of which differ from that of *Microbracon hebetor* Say just described. According to him, the form and structure of the glands and their reservoir remain constant in the one tribe, so that they can be used as diagnostic characters to that tribe. But, in the opinion of the present investigator, the work done in that field is not sufficient to warrant such a statement.

There is no doubt, that the reservoir in this insect acts also as a pumping apparatus, for driving out the secretion of the glandular tubes into the common glandular duct, and for pumping the secretion from the lumen of the tubes into its own lumen. When the powerful longitudinal muscles of the reservoir contract, the volume of the reservoir is decreased, and some of its fluid contents is driven backwards to the opening of the common glandular duct, which, at the same time, is drawn forwards into the vestibule by the muscle contraction. When the opening of the common glandular duct is drawn into the vestibule, the slanting openings of the glandular tubes are closed and thus the influx of the outgoing fluid into these tubes is prevented. On the relaxation of its longitudinal muscles, the reservoir resumes its former volume by the elasticity of the chitinous spiral, and in so doing, it draws some of the secretion of the eight glandular tubes into its cavity.

The alkaline gland is situated between the quadrate and oblong plates of the « sting », and it is very probable that, in stinging, the gland is squeezed between these plates and thus its secretion comes out.

IX. SUMMARY

(1) *Microbracon hebetor* Say has four larval instars. The alimentary canal and respiratory system of the last instar are described.

(2) In the adult insect the head and its appendages are described. Only labro-clypeus, clypeo-frontal and gular sutures are found.

Tentorium has its anterior arms forming main part, dorsal arms are attached to ocular sclerite, posterior arms are very short and have no pits, body of tentorium forms a bridge across occipital foramen.

Antennae are described in some detail. The male flagellum is longer than that of the female. Deformation is frequent in flagellum. Through each antenna run a double nerve, a trachea and a blood vessel. Antennal muscles do not extend distally more than the basis of the pedicel. Rhinaria are sunk canaliculus of the antennal wall covered with membrane, and in the middle of each is situated an elliptical placoid sensilla. The rhinaria are found only on the flagellum and give it a ribbed appearance. Number of rhinaria is not the same on both antennae of each individual and is different in both sexes. Results of actual counts from cross-sections are given in Table II ; in a male, left antenna has 292 rhinaria, right antenna 279 ; in a female, left antenna has 171 and right has 166. The nerve branch from each placoid sensilla joins the antennal double nerve in the segment proximal to that in which the sensilla is situated. That the rhinaria contain fluid suggests that the placoid sensillae are probably olfactory. Johnston's organ is found and described. Bischoff (1927) states that placoid sensillae are the only type found in *Braconidae*. Trichoid as well as coeloconic sensillae are found on the flagellum of this insect and are described.

The mouth parts are adapted for biting and lapping and consist of : epipharynx, hypopharynx, labrum, labium, maxillae and mandibles all of which are described.

(3) The exo- and endoskeleton of the thorax are described and figured in details and represent a specialised Hymenopterous thorax. The first abdominal tergum is solidly attached to the thorax.

The wings have three axillary sclerites at the base of each. Sensillae are found at bases of all wings, and at the parastigma of the mesothoracic pair. Venation of both wings is described on both Comstock-Needham system and Marshall's system of *Braconidae*. Wing coupling apparatus consists of a thickened rib in the mesothoracic and three hamuli in the metathoracic wings. Direct and indirect wing muscles are described.

In the legs the three coxae are different in size and shape. The so called second trochanter segment is shown to be a proximal part of the femur. Praetarsus is described in some detail and consists of two claws, and a median adhesive organ strengthened dorsally by the orbicula, and ventrally by the

calcanea to which the tarsal tendon is attached. The distal part of the median adhesive organ is the arolium which has at its ventral side a chitinous bow. A table of nomenclature used by different authors for the different parts of the pretarsus is given. The way by which the insect ascends and descends smooth perpendicular glass and walks on the underside of horizontal smooth surfaces is not clear.

(4) The abdomen is composed of ten segments. The sterna are mostly membranous. The first abdominal sternum still lies in the abdomen and has not been shifted to the thorax as the first abdominal tergum. The male genital opening is between the ninth and tenth sterna, the female genital pore lies between the eighth and ninth sterna. The cerci are one-segmented and are situated in the membranous part posterior to the ninth sternum.

A gland on the eigth abdominal tergum of the male is newly described.

(5) All parts of the alimentary canal are described in some detail. Pharynx has a pharyngeal plate in its ventral wall; on this plate there are two groups of gustatory sensillae. Three longitudinal folds are described in the proventriculus. The cardiac invagination « valve » does not extend very far in mid-gut. Striated hem of mid-gut forms peristrophic membrane. Malpighian tubes are 12-14, and open between and hind gut. The rectal pads « glands » are four in number and are described in some detail. Thoraci-glands open by a common duct on dorsal side of labium.

(6) Blood has a faint yellowish tinge and contains few granular leucocytes. There is a dorsal diaphragm situated in the gaster, but no ventral diaphragm. Heart extends from seventh to second abdominal segments. Aorta bifurcates in head giving a branch to each antenna. Heart has five chambers and five pairs of ostia.

(7) The central nervous system is described. Mushroom bodies are well developed. In thorax main nerve centres are two and there is a small secondary centre between them. In the gaster the apparent number of ganglionic centres is four in both sexes, but sections reveal that the last ganglionic centre is composed of one ganglion more than that of the female.

(8) The tracheal system of *Microbracon hebetor* Say agrees with that of *Dorycles gallicus* Reinh. which is described in detail by Seurat (1899); therefore its description is not included in this paper. The spiracles of *Microbracon hebetor* Say are described and the structure and mechanism of an abdominal spiracle is described in detail.

(9) Male reproductive organs are described in detail. There are no special vesiculae seminalis. The accessory glands, unlike the case in many other Hymenoptera, are externally bound together but internally they are separate; ejaculatory duct is very short. Histology of the organs is described.

Male genitalia consist if a basal piece whose homology is not clear, two

external valves which are the coxites of the ninth sternum, two internal valves with their processes which are the parameres, and the penis which is formed by the fusion of the two penis lobes and is thus homologous with the aedeagus in other orders.

The reproductive system of female is described. Each ovary has two polytrophic ovarioles. There is no ovarian ligament. The two oviducts are short, vagina short and wide. Spermatheca spherical with two tubular spermathecal glands. There are no collateral glands; the structure of the system is described.

The female genitalia are fundamentally composed as in other insects of three pairs of gonapophyses, and of the quadrate plate, which is part of the ninth tergum, the fulcral or triangular plate which is part of the eighth sternum, and the inner or oblong plate which is part of the ninth sternum. The stylet sheath has no barbs, the stylet has five barbs on its lateral outer side. All parts are described in detail.

(10) The glands of the sting and their histology are described in detail. The alkaline gland is single gland which open directly at the anterior end of the bulb of the stylet sheath. The acid glands are formed by a complex apparatus consisting of eight tubular glands surrounding a non glandular reservoir and having in common with it a duct which is also glandular. This duct enters the bulb of the stylet sheath on the left side and opens in it. The walls of the duct have two kinds of cells, columnar cells which are easily separated from one another, and, at their necks, small spherical cells which open with short ducts in the lumen of the common duct; these small spherical unicellular glands were not described by Bordas (1897 and 1908), Janet (1898), Seurat (1899) and Pavlovski (1914), and thus are new finding.

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PLATES I-XVII

Explanation of Plate I

Fig. 1. — The mating position. — × 12.

Fig. 2. — The egg. — × 28.

Fig. 3. — First larval stage (dorsal view). — × 60.

Fig. 4. — Last larval stage (side view). — × 20.5.

Fig. 5. — Prepupa (ventral view) : The black substance at the posterior end of the cocoon is the faeces. — × 24.

Fig. 6. — Female pupa (ventral view). — × 24.

Fig. 7. — Female adult (dorsal view). — × 20.

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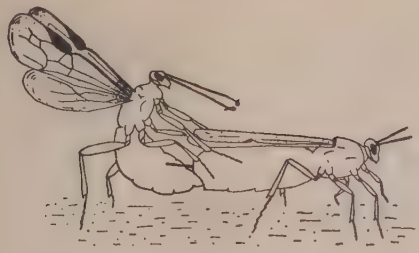

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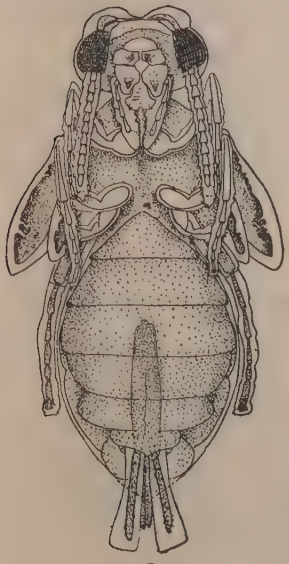

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5

Studies in the structure
of *Microbracon hebetor* Say

Explanation of Plate II

Fig. 8. — Tracheal system of the last larval instar (side view), and an enlarged spiracular branch with spiracle at the end. — × 34.5.

Fig. 9. — Tracheal system of last larval instar (ventral view). — × 20.

Fig. 10. — Head, pro- and mesothorax of last larval instar (ventral view) : The mouth parts are clearly shown. Labium in the middle with two labial palps to the posterior and the opening of the salivary gland to the anterior. On both sides are the maxillae with thin palps which is seen in the middle. The mandibles and labrum can also be seen. — Enlarged.

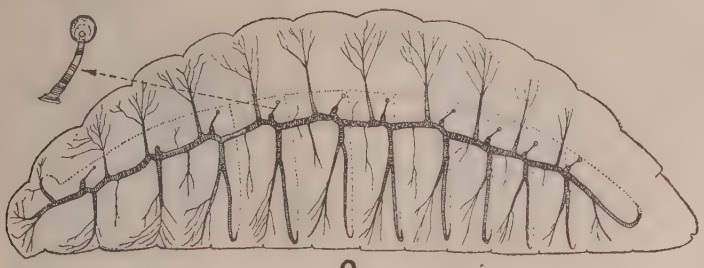
Fig. 11. — Schematic diagram showing alimentary canal and salivary glands : *a*, anus ; *m*, mouth ; *mg*, mid-gut ; *mt*, malpighian tubules ; *osg*, opening of salivary glands ; *sg*, salivary glands. — × 19.

Fig. 12. — Median longitudinal section in the posterior end of the larva : *a*, anus ; *hg*, hind-gut ; *mg*, mid-gut ; *mgw*, mid-gut wall ; *mt*, malpighian tubules ; *pm*, periotrophic membrane ; *sg*, salivary glands. — × 100.

Fig. 13. — Median longitudinal section in the anterior end of the larva ; *m*, mouth ; *mg*, mid-gut ; *ph*, pharynx ; *pm*, periotrophic membrane ; *sg*, salivary gland ; *sub.œs.g*, sub œsophageal ganglion. — × 100.

Prof. Dr Hamid Seleem Soliman

Plate II



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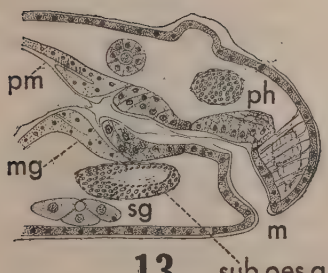

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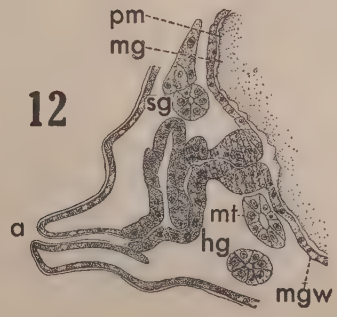

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Explanation of Plate III

Fig. 14. — Anterior aspect of head : *cly*, clypeus ; *lbr*, labrum ; *md*, mandible ; *mxp*, maxillary palp ; *oc*, ocellus ; *tnp*, tentorial pit. — × 80.

Fig. 15. — Posterior aspect of head : *cd*, cardo ; *lbm*, labium ; *md*, mandible ; *mxp*, maxillary palp ; *oc*, ocellus ; *st*, stipes ; *tnb*, tentorial body seen through the occipital foramen. — × 80.

Fig. 16. — Cross-section in antenna passing through the telescoped distal end of the pedicel into the proximal end of the first segment of flagellum : *bv*, blood vessel ; *fl1*, first segment of flagellum ; *jp*, pit of Johnston's organ ; *nv*, nerve ; *pd*, pedicel ; *tr*, trachea. — × 80.

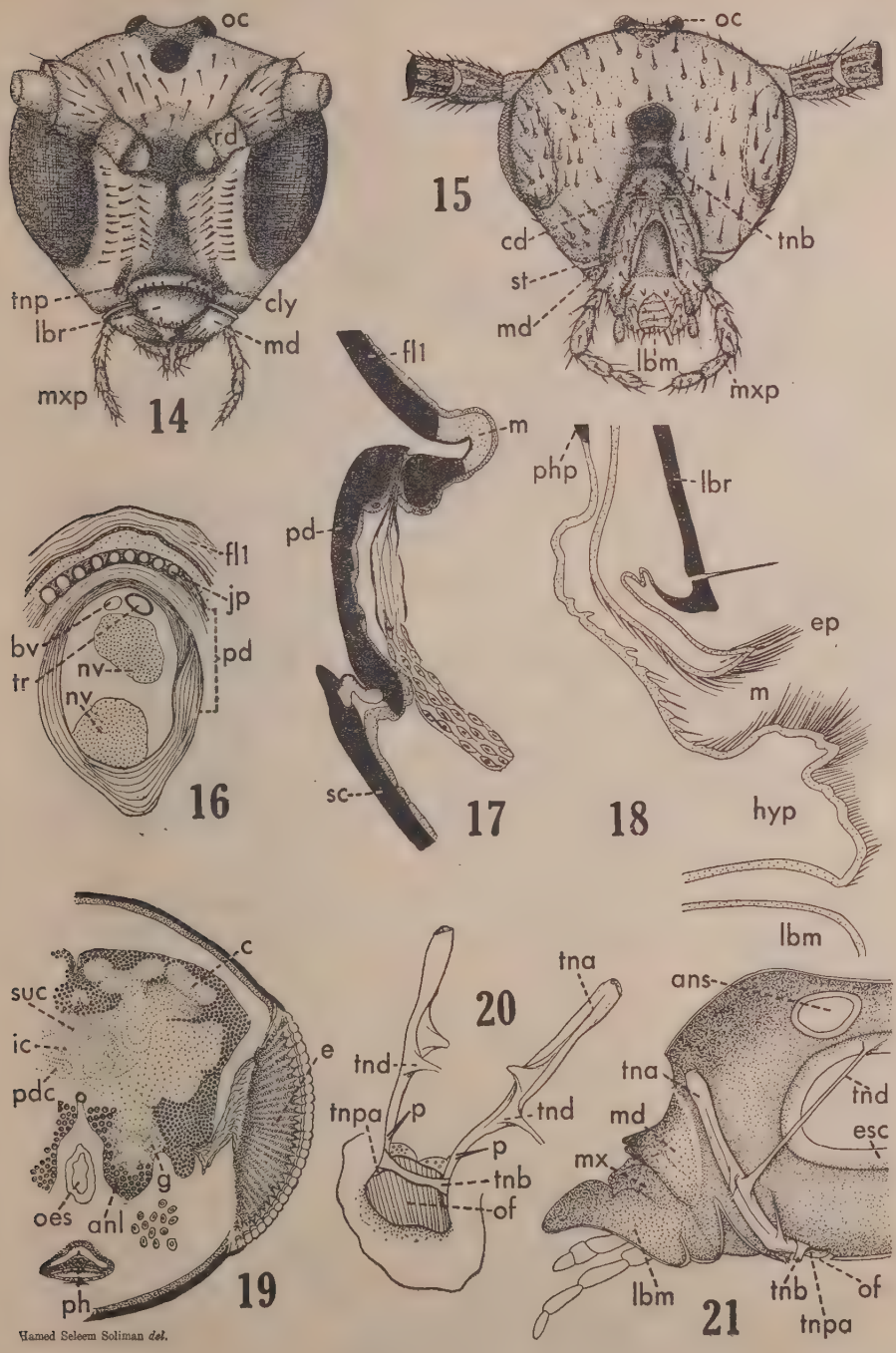
Fig. 17. — Longitudinal section passing through left wall of proximal end of antenna and through one of the pits of Johnston's organ : *fl1*, first segment of flagellum ; *m*, articulatory membrane ; *pd*, pedicel ; *sc*, scape. — × 736.

Fig. 18. — Median longitudinal section through mouth : *ep*, epipharynx ; *hyp*, hypopharynx ; *lbm*, labium ; *lbr*, labrum ; *m*, mouth ; *php*, pharyngeal plate (distal tip). — × 640.

Fig. 19. — Frontal section in left side of head : *anl*, antennal lobe of brain ; *c*, calyx of mushroom body ; *e*, compound eye ; *g*, glumeruli ; *ic*, inferior capsule of the central body of protocerebrum ; *oes*, oesophagus ; *ph*, pharynx ; *pdc*, peduncle of mushroom bodies ; *suc*, superior capsule of the central body of cerebrum (the root of median ocellar nerve can be seen dorsal to *suc*, and it is clear that it is of double origin). — × 140.

Fig. 20. — Tentorium dissected out with a piece of the occiput (posterior aspect) : *of*, occipital foramen ; *p*, chitinous process ; *tna*, anterior arms ; *tnb*, tentorial body ; *tnd*, dorsal arms (cut near their origin from the anterior arms ; *tnpa*, tentorial posteriol arms. — × 96.

Fig. 21. — Right side of head capsule seen from inside : *ans*, antennal socket ; *esc*, eye sclerite ; *lbm*, labium ; *md*, mandible ; *mx*, maxilla ; *of*, occipital foramen ; *tna*, tentorial anterior arm ; *tnb*, tentorial bridge or body, cut ; *tnd*, tentorial dorsal arm ; *tnpa*, tentorial posterior arm. — × 84.



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Explanation of Plate IV

Fig. 22. — Labrum and epipharynx dissected out with some muscles (posterior aspect) : *ep*, epipharynx ; *lbr*, labrum ; *sn*, sensillae in dorsal wall of pharynx. — × 188.

Fig. 23. — Left mandible (dorsal view) : *abdm*, abductor muscles ; *adm*, adductor muscles. — × 188.

Fig. 24. — Right maxilla (outside aspect) : *cd*, cardo ; *g*, galea ; *l*, lacinia ; *st*, stipes. — × 188.

Fig. 25. — Cardines (dorsal aspect) : *cd*, cardo ; *st*, stipes. — × 188.

Fig. 26. — Labium (lateral aspect) : *gl*, glossa ; *hyp*, hypopharynx. — × 188.

Fig. 27. — Occipital foramen and area round it, to show gula : *cd*, cardo : *gu*, gula ; *gus*, gular suture ; *of*, occipital foramen ; *sn*, sensillae ; *tna*, tentorial anterior arm seen through chitin ; *tnb*, tentorial body seen through occiptal foramen. — × 240.

Fig. 28. — Labium (dorsal aspect) : *gl*, glossa ; *hyp*, hypopharynx ; *pg*, paraglossa ; *sn*, sensillae ; *sgo*, opening of salivary duct. — × 188.

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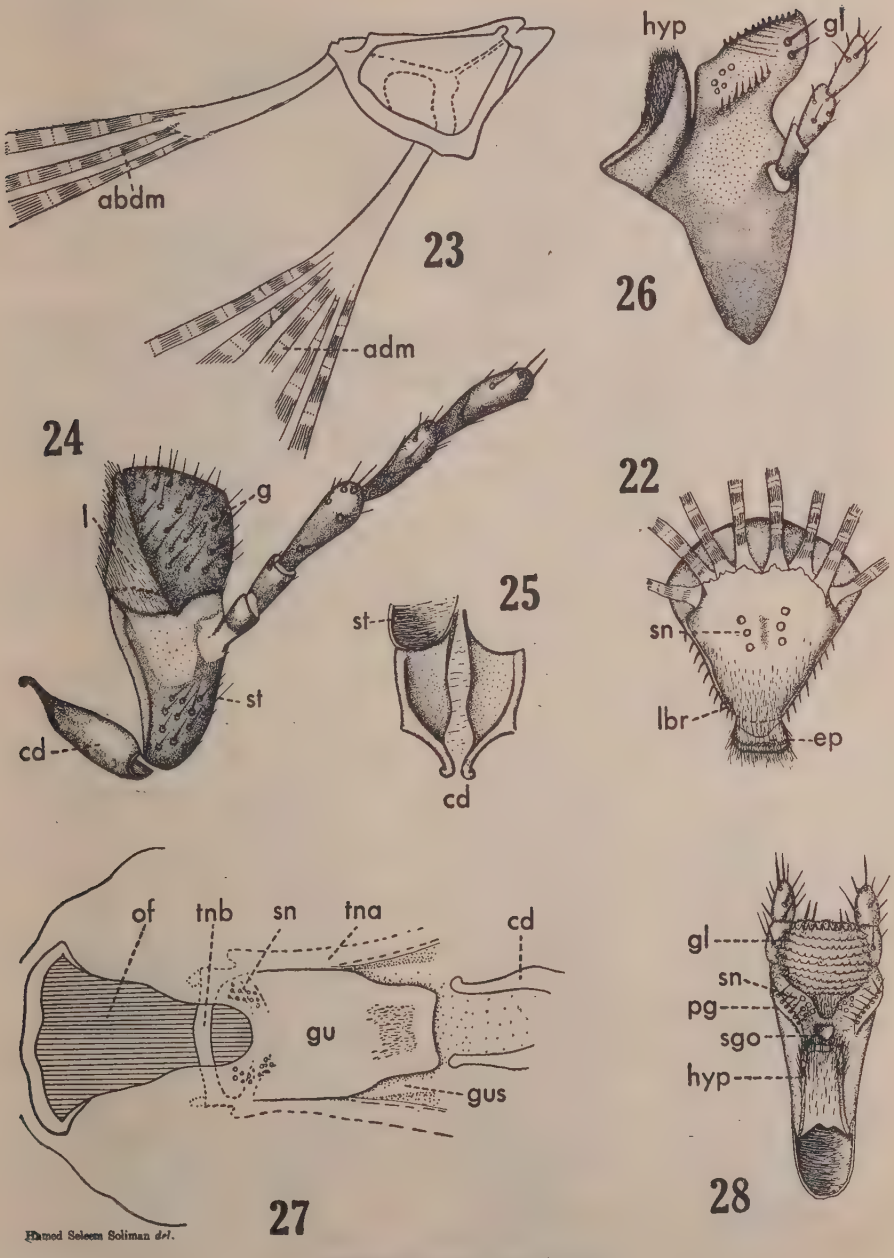

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Explanation of Plate V

Fig. 29. — Male and female antennae ; *pd*, pedicel ; *sc*, scape ; *tcz*, testaceous coloured zone. — × 44.

Fig. 30. — Schematic cross-section in first flagellar segment of female's left antenna showing dorso-lateral sector (thin walled) devoid of rhinaria. — Enlarged.

Fig. 31. — Longitudinal section in head passing through basis of antenna : *anl*, antennal lobe of brain ; *annv*, antennal nerve ; *ansc*, antennal sclerite ; *cly*, clypeus ; *fc*, fat cells ; *lbr*, labrum ; *rd*, radicle ; *tna*, tentorium anterior arm (the section does not pass through the whole length of the tentorial arm). — × 176.

Fig. 32. — Cross-section in an antennal segment not passing through the placoid sensillae : *bv*, blood vessel ; *e*, reflected edge of rhinarium ; *hyp*, hypodermis ; *m*, membrane ; *nv*, nerve ; *rh*, rhinarium ; *tr*, trachea ; *tsn*, trichoid sensilla. — × 640.

Fig. 33. — Articulation of antenna with head : *ansc*, antennal sclerite ; *chp*, chitinous pivot ; *rd*, radicle ; *sc*, scape. — × 60.

Fig. 34. — Cross-section passing through placoid sensilla of advanced pupa : *ts*, terminal strand ; *vc*, vacule (sense cells send processes into vacule). — × 640.

Fig. 35. — Longitudinal section in area between rhinaria showing coeloconic sensilla : *nv*, nerve. — × 640.

Fig. 36. — Longitudinal section passing through two parts of adjacent antennal segments and through a rhinarium : *bm*, basement membrane ; *e*, reflected edge of rhinarium ; *hyp*, hypodermis ; *nvb*, branch of nerve innervating placoid sensilla ; *rh*, rhinarium ; *tsn*, trichoid sensilla. — × 640.

Fig. 37. — Part of male antenna showing deformation in three segments (the rhinaria on the proximal and distal segments are not inserted). — × 176.

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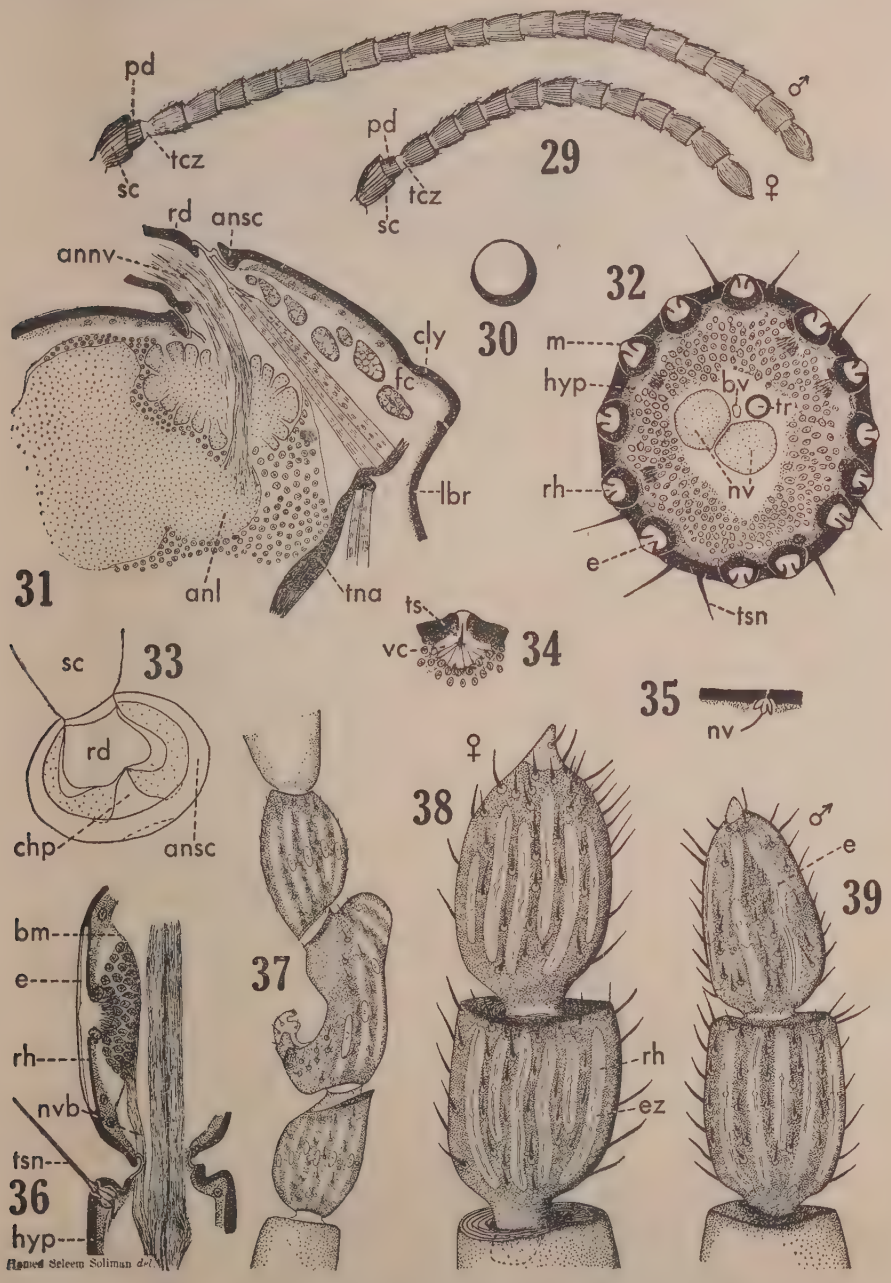

Studies in the structure
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Explanation of Plate V (continuation)

Fig. 38. — Tip of a female's antenna : *rh*, rhinarium ; *ez*, elliptical zone where the chitinous basis of the rhinarium is missing, and where the internal elements of the placoid sensilla communicate with the external elements. — × 344.

Fig. 39. — Tip of a male's antenna : *e*, reflected edge of rhinarium seen through membrane. — × 344.

Explanation of Plate VI

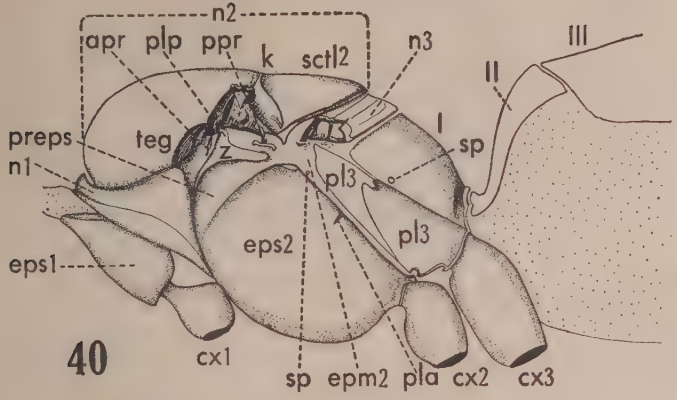
Fig. 40. — Lateral aspect of thorax : *apr*, anterior parapteron or basalare plate ; *cx1*, *cx2* and *cx3* pro-, meso- and metacoxae ; *epm2*, mesothoracic epimeron ; *eps1* and *eps2*, pro- and meso-episterna ; *k* scuto-scutellar suture ; *n1*, *n2* and *n3*, pro-, meso- and metanotum ; *pl3*, metathoracic pleura ; *pla*, mesopleural arm seen through integument ; *plp*, pleural process ; *prp*, posterior parapteron or subalare plate ; *preps*, pre-episternum of mesothorax ; *sctl2*, scutellum of mesothorax ; *sp*, spiracle ; *teg*, tegula ; *z*, episternal division ; *I*, *II* and *III*, first, second and third abdominal terga. — × 62.5.

Fig. 41. — Ventral aspect of thorax : *cxc1*, *cxc2* and *cxc3*, pro-, meso-, and metacoxal cavities ; *eps1*, pro-episternum ; *n1*, pronotum ; *oc*, occipital process ; *ph1*, anterior mesophragma ; *preps*, pre-episternum of mesothorax ; *s1*, *s2* and *s3*, pro-, meso- and metasterna ; *I*, first abdominal tergum seen from inside. — × 62.5.

Fig. 42. — Dorsal aspect of thorax : *awp*, anterior wing process ; *axc*, axillary cord ; *h*, faint suture ; *j*, border of the area of attachment of dorsoventral indirect wing muscles ; *k*, scuto-scutellar suture ; *n3*, metanotum ; *pn2*, meso-postnotum seen inside ; *pwp*, posterior wing process ; *q*, border of area of attachment of median longitudinal indirect wing muscles ; *sctl2*, scutellum of mesothorax ; *sp*, spiracle ; *teg*, tegula ; *I*, first abdominal tergum. — × 62.5.

Fig. 43. — Mesopostnotum dissected out with the posterior mesophragma : *ph2*, mesophragma ; *pn2*, mesopostnotum ; *w*, lateral anterior coner of mesophragma. — × 62.5.

Fig. 44. — Pronotum (inside aspect looked at from posterior : *sp*, first thoracic spiracle. — × 62.5.



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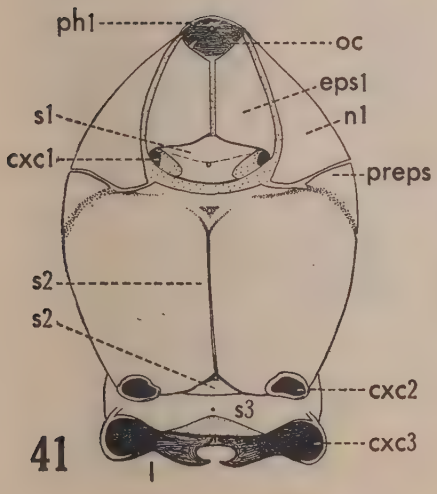

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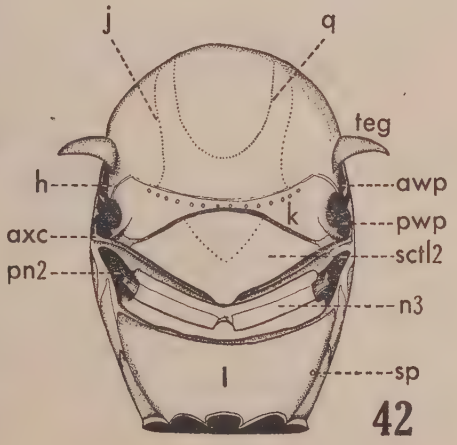

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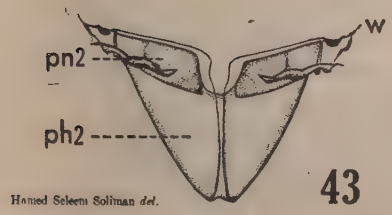

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Explanation of Plate VII

Fig. 45. — Posternum dissected out (ventral aspect) : *a*, prosternal arm ; *f1p*, profurcal pit ; *spe*, posterior edge of prosternum. — × 172.

Fig. 46. — Metasternum dissected with posterior part of mesosternum, and with basis of the first abdominal segment which was cut laterally and turned over to show the coxal cavity end view : *cxc2* and *cxc3*, coxal cavities of meso- and metathoracic legs ; *fp*, furcal pits ; *s2* and *s3*, meso- and metasterna ; *I*, first abdominal segment. — × 60.

Fig. 47. — Profurca dissected out with prosternum (anterior aspect) : *fa*, furcal arm ; *fs*, furcal stem ; *s1*, prosternum ; *spe*, posterior edge of prosternum seen behind the furca. — × 100.

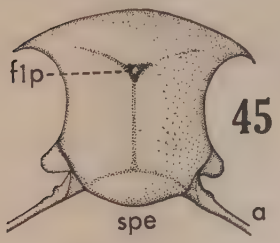
Fig. 48. — The inside of propectus (dorsal view) : *a*, prosternal arm ; *eps*, episternum ; *fa*, furcal arm ; *m*, folded cuticle ; *os*, occipital process ; *s1*, prosternum ; *x*, chitinous process ; *y*, faintly scleritised area. — × 100.

Fig. 49. — Propectus (lateral aspect) : *a*, prosternal arm ; *cxc1*, procoxal cavity ; *eps*, episternum ; *fa*, furcal arm ; *fs*, furcal stem ; *os*, occipital process ; *s1* prosternum ; *x*, chitinous process ; *y*, faintly scleritised area. — × 96.

Fig. 50. — Right occipital process of female dissected out with a piece of pro-episternum (inside aspect, sensillae seen through) : *epsw*, anterior episternal edge ; *oc*, occipital process ; *sn*, sensilla. — × 652.

Fig. 51. — Basal part of metacoxa showing sensillae on meron : *sn*, sensillae. — × 240.

Fig. 52. — Right episternum and pleuron (inside aspect) : *ap*, pronator disc (this plate is connected to the anterior paraptera with the scleritised prolongation *pr*) ; *fpl*, mesofurcal plate ; *1fs*, stem of mesofurca ; *epm*, epimeron ; *eps*, episternum ; *pla2*, pleural arm of mesothorax ; *plp*, mesopleural process ; *plr*, pleural ridge ; *plrb*, connection showing the continuation of the pleural ridge (this connection does not appear externally in the pleural suture [Plate VI, figure 40]) ; *pr*, scleritised prolongation between the pronator disc and the anterior paraptera ; *preps*, pre-episternum ; *s2*, mesosternum ; *z*, mesopleural tertiary division. — × 61.5.



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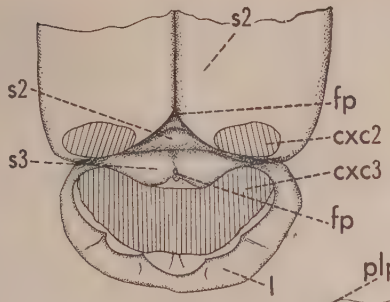

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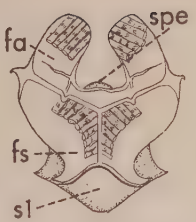

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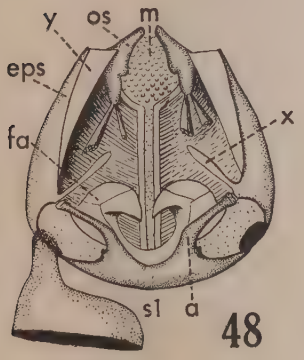

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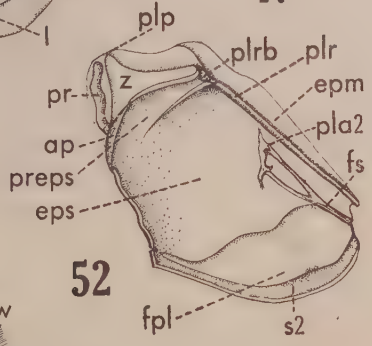

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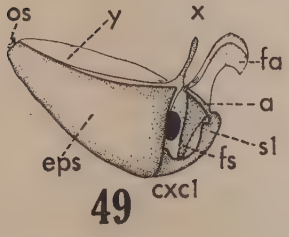

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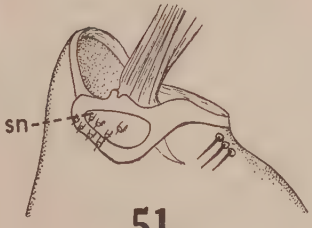

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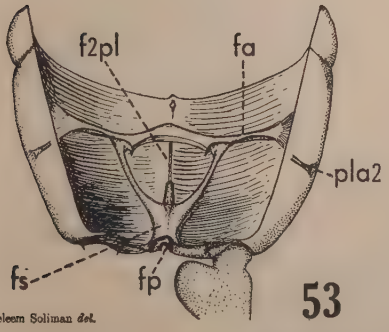

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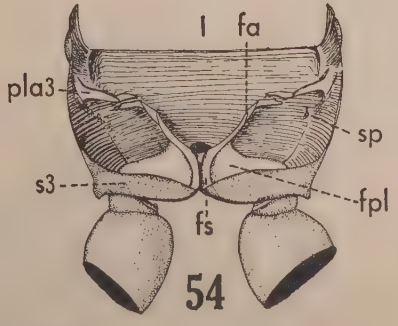

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Explanation of Plate VII (continuation)

Fig. 53. — Mesopectus from inside (dorsal aspect) : *fa*, furcal arm ; *fp*, furcal pit ; *f2pl* (=*fpl* of figure 52), mesofurcal plate ; *fs*, stem of mesofurca ; *pla2*, pleural arm seen through pleura. — × 61.5.

Fig. 54. — Sternum and pleuron of metathorax dissected out and looked at from inside (anterior ventral aspect to show metafurca, and first abdominal tergum also shown from inside) : *fa*, furcal arm ; *fpl*, metafurcal plate ; *fs*, stem of metafurca ; *pla3*, metapleural arm ; *s3*, reflexed anterior edge of metasternum ; *sp*, spiracle of first abdominal tergum seen from inside ; *I*, first abdominal tergum. — × 61.5.

Explanation of Plate VIII

Fig. 55. — Cross-section in thorax just anterior to forewing : *ao*, aorta ; *dm*, direct wing muscles ; *idv*, indirect dorso-ventral muscles ; *imp*, indirect median dorsal muscles ; *pm*, pronator muscles ; *tr*, trachea. — × 60.

Fig. 56. — Area round stigma of anterior wing to show sensillae *sn*. — × 61.5.

Fig. 57. — Base of hind wing : *1ax*, *2ax*, and *3ax*, first, second and third axillary sclerites ; *md*, median plate of wing base ; *p*, basis of subcosta. — × 27.5.

Fig. 58. — Base of fore wing : *1ax*, *2ax* and *3ax*, first, second and third axillary sclerites ; *md*, median plate of wing base ; *p*, basis of subcosta ; *sn*, group of sensory hairs. — × 27.5.

Fig. 59. — *A*, *B*, and *C*, anterior, mid and hind left legs : *cox*, coxa ; *fe*, femur ; *te*, tibia ; *tr*, trochanter ; *t1*, *t2*, *t3*, *t4* and *t5*, tarsal segments — × 100.

Fig. 60. — Male prepupa (ventral aspect) showing teratology in right proleg : *fg*, deformed proleg. — × 40.

Fig. 61. — Cross-section through non scleritised cuticle found in neck and between pro- and mesopectus : *cu*, cuticle ; *hyp*, hypodermis. — × 640.

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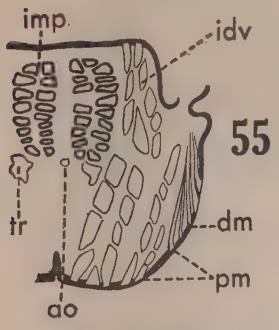

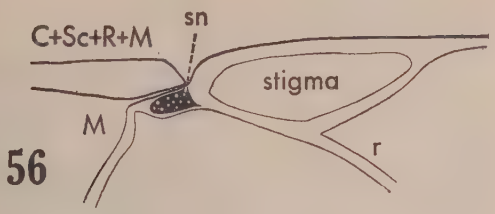

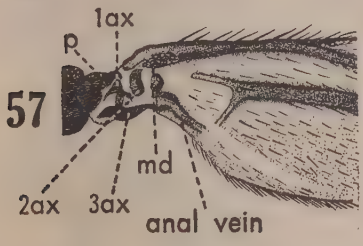

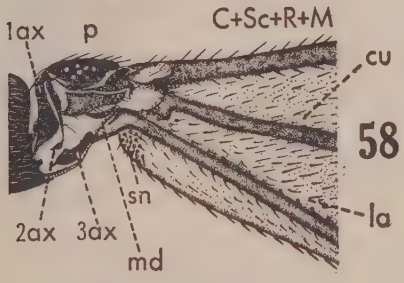

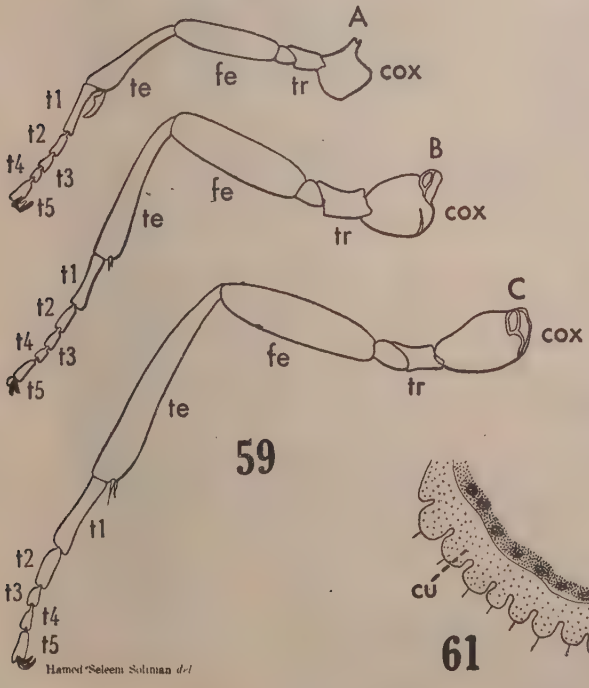

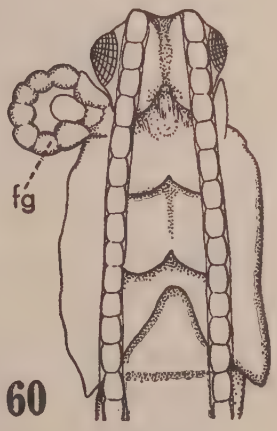

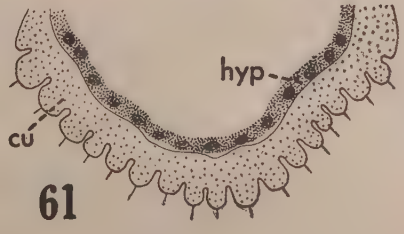

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Explanation of Plate IX

Fig. 62. — Pretarsus (lateral aspect) : *ar*, arolium ; *br*, bristle on claw ; *bw*, bow of arolium ; *cal*, calcanea ; *cl*, claw ; *ed*, scleritised edge of last tarsal segment ; *fl*, gleitflache ; *orb*, orbicula ; *pl*, planta ; *tn*, tendon ; *ung*, unguifer. — × 640.

Fig. 63. — Pretarsus (dorsal aspect) : *ar*, arolium ; *bw*, bow of arolium ; *cl*, claw ; *cs*, campaniform sensilla ; *orb*, orbicula ; *ung*, unguifer. — × 640.

Fig. 64. — Pretarsus (ventral view) : *ar*, arolium ; *bw*, bow of arolium ; *cal*, calcanea. — × 640.

Fig. 65. — Cross-section in pretarsus passing through the planta : *ar*, arolium ; *cl*, claw ; *orb*, orbicula ; *pl*, planta. — × 640.

Fig. 66. — Cross-section in pretarsus passing through opening of claws into adhesive organ (the section is somewhat slanting) : *cal*, calcanea ; *cl*, claw ; *lpd*, latero dorsal process of claw ; *nv*, nerve ; *orb*, orbicula ; *tr*, trachea. — × 640.

Fig. 67. — Dorsal aspect of pretarsus showing arolium half open : *ar*, arolium ; *bw*, bow of arolium ; *cl*, claw ; *cs*, campaniform sensilla ; *ldp*, latero dorsal process of claw ; *orb*, orbicula. — × 640.

Fig. 68. — Trochanter and base of femur cut open : *fm*, femur ; *trr*, trochanter (the fan-shaped muscles are some of the reductor femories, the other muscles are the tibial flexor : both muscles are attached to the real base of the femur showing that the « second trochanter » is morphologically a part of the femur). — × 160.

Fig. 69. — Distal end of tibia and metatarsus of anterior leg showing antenna-cleaner formed by the modified tibial spur *anc* and the curved metatarsus *mt* ; *tbc*, tibia. — × 244.

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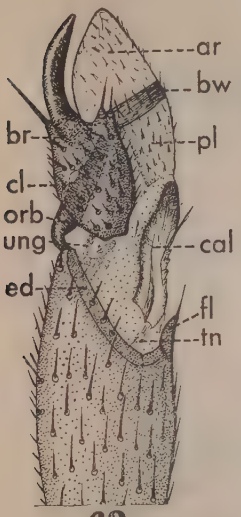
Plate IX



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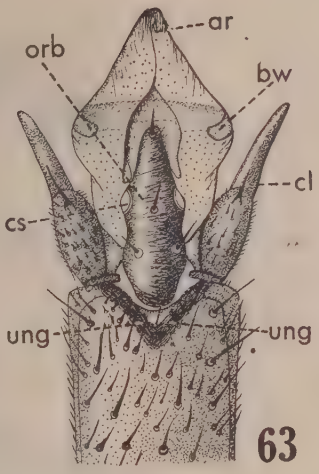

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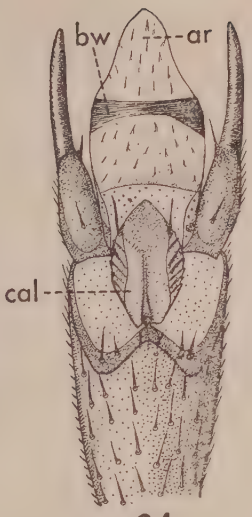

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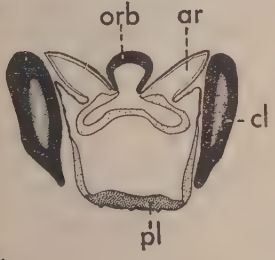

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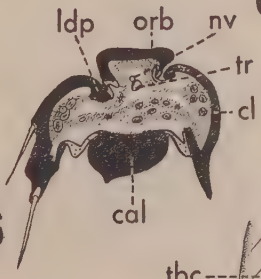

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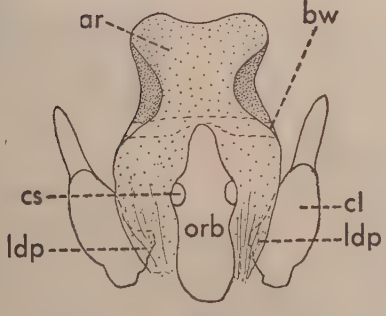

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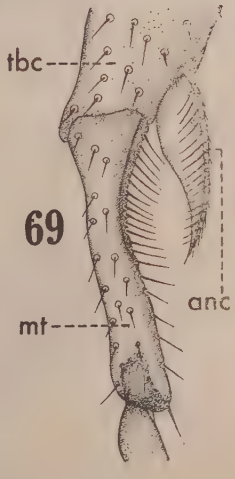

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Explanation of Plate X

Fig. 70. — Female's abdomen (lateral aspect) : *gd*, palps or guides of ovipositor and sting ; *sp*, spiracle ; *stn*, sternite ; *II* and *VII*, second and seventh abdominal terga. — × 31.

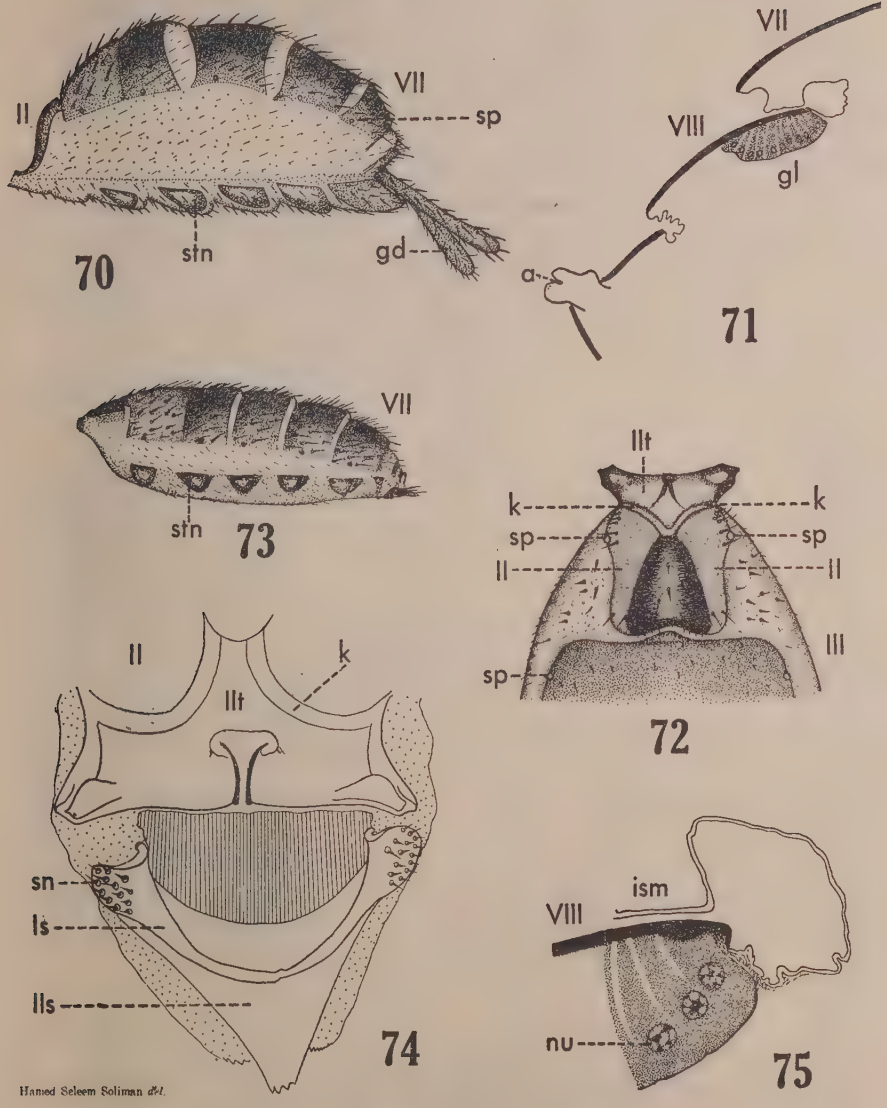
Fig. 71. — Longitudinal section in posterior end of male's abdomen showing eighth abdominal gland *gl ; a*, anus ; *VII* and *VIII*, seventh and eighth abdominal terga. — × 168.

Fig. 72. — Second and part of the third abdominal terga (dorsal aspect) : *k*, suture ; *sp*, spiracle ; *II* and *III*, second and third abdominal terga ; *IIt*, anterior part of second abdominal tergum. — × 68.

Fig. 73. — Male's abdomen (lateral aspect) : *stn*, sternite ; *VII*, seventh abdominal terga. — × 29.5.

Fig. 74. — Drawing of anterior of gaster dissected and spread flat on the slide (anterior aspect) : *k*, suture ; *sn*, sensillae ; *Is*, first abdominal sternum (ventral aspect) ; *II*, second abdominal terga ; *IIs*, second abdominal sternum ; *IIt*, anterior part of second abdominal tergum. — × 240.

Fig. 75. — Magnified anterior part of male's eighth abdominal gland : *ism*, intersegmental membrane ; *nu*, nucleus of glandular cell ; *VIII*, eight abdominal terga. — × 640.



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Explanation of Plate XI

Fig. 76. — Posterior part of female's abdomen, last segments pulled out (lateral aspect) : *a*, anus ; *cr*, cercus ; *gd*, palp-like processes, or guides of ovipositor ; *op*, oblong plate ; *qp*, quadrate plate ; *sth*, stylets and their sheath ; *tp*, triangular plate ; *VIII* and *IX*, eighth and ninth terga ; *Xs*, tenth sternum. — × 60.

Fig. 77. — Posterior part of female's abdomen (end view) : *a*, anus ; *cr*, cercus ; *sp*, spiracle ; *VIII* and *IX*, eighth and ninth terga ; *Xs*, tenth sternum. — × 58.5.

Fig. 78. — Ovipositor (ventral aspect) : *cr*, cercus ; *gd*, palp-like processes ; *op*, oblong plate ; *or*, scleritised rib in inner or oblong plate ; *qp*, quadrate plate ; *qr*, scleritised rib in outer or quadrate plate ; *sn*, sensillae ; *shb*, sheath bulb ; *sth*, stylets and their sheath ; *tp*, triangular plate ; *n*, scleritised rib on outer edge of oblong plate ; *IX*, ninth terga. — × 96.

Fig. 79. — Tip of stylet sheath : *sn*, sensillae. — × 640.

Fig. 80. — Tip of guides of ovipositor : *A*, outer side ; *B*, inner side, showing groove. — × 304.

Fig. 81. — Tip of right stylet (ventral aspect) : *b*, first barb. — × 640.

Fig. 82. — Cross-section in ovipositior at a level just before the folded part of the guides *gd* (Fig. 78) : *d*, partition in the stylet sheath ; *gd*, guides or palp-like appendages ; *hyp*, hypodermis ; *nv*, nerve ; *sh*, stylet sheath ; *st*, stylets ; *tr*, trachea. — × 640.

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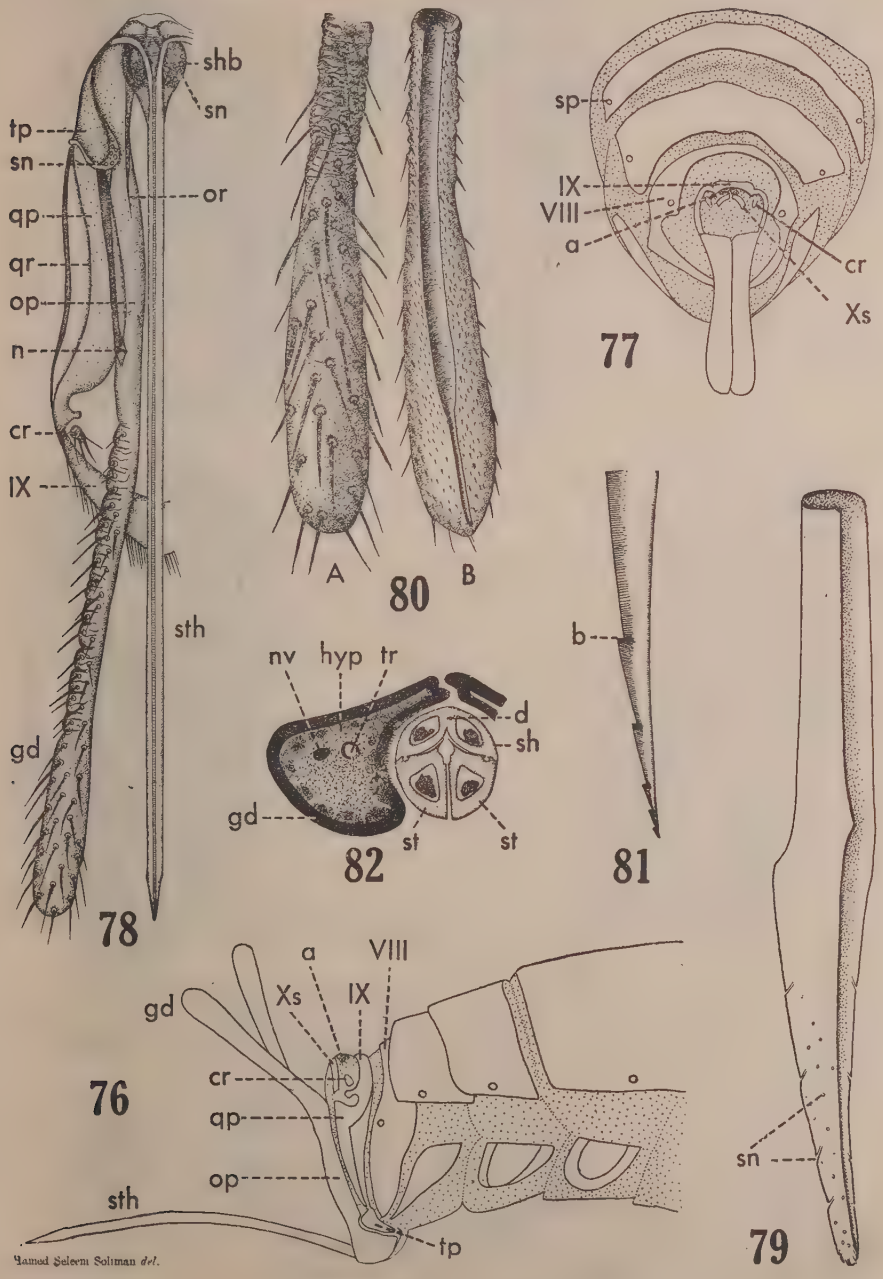
Plate XI



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Explanation of Plate XII

Fig. 83. — Median longitudinal section in head: *cly*, clypeus; *ep*, epipharynx; *gu*, gula; *hyp*, hypopharynx underwhich runs the common duct of the salivary glands; *lbm*, labium; *lbr*, labrum; *md*, mandible (section passes through the top of the mandible); *oes*, oesophagus; *tnb*, tentorial body. — × 96.

Fig. 84. — Pharyngeal plate dissected out (dorsal aspect) : *a*, arm; *sn*, sensillae (its anterior end points towards the top of the page). — × 96.

Fig. 85. — Cross-section through oesophagus showing longitudinal muscles *lm*, and circular muscles (epithelium thrown into folds). — × 640.

Fig. 86. — Longitudinal section through proventriculus : *cr*, crop; *prv.*, proventriculus; *vn*, ventriculus. — × 164.

Fig. 87. — Cross-section through proventriculus : *cm*, circular muscles; *lm*, longitudinal muscles. — × 640.

Fig. 88. — Dissection of adult drawn from left side : *ap*, pronator disc; *ht*, heart; *idm*, interior direct wing muscles; *imp*, indirect median dorsal muscles; *k*, scuto-scutella suture; *nr*, notal ridge; *ph1* and *ph2*, mesothoracic phragma; *pr*, scleritised prolongation connected to anterior parapteron. — × 46.5.

Fig. 89. — Cross-section through crop : *chi*, chitinous interna; *cm*, circular muscles; *lm*, longitudinal muscles; *lu*, lumen. — × 400.

Fig. 90. — Longitudinal section in malpighian tube. — × 640.

Fig. 91. — Cross-section in malpighian tube : *lu*, lumen; *nu*, nucleus. — × 640.

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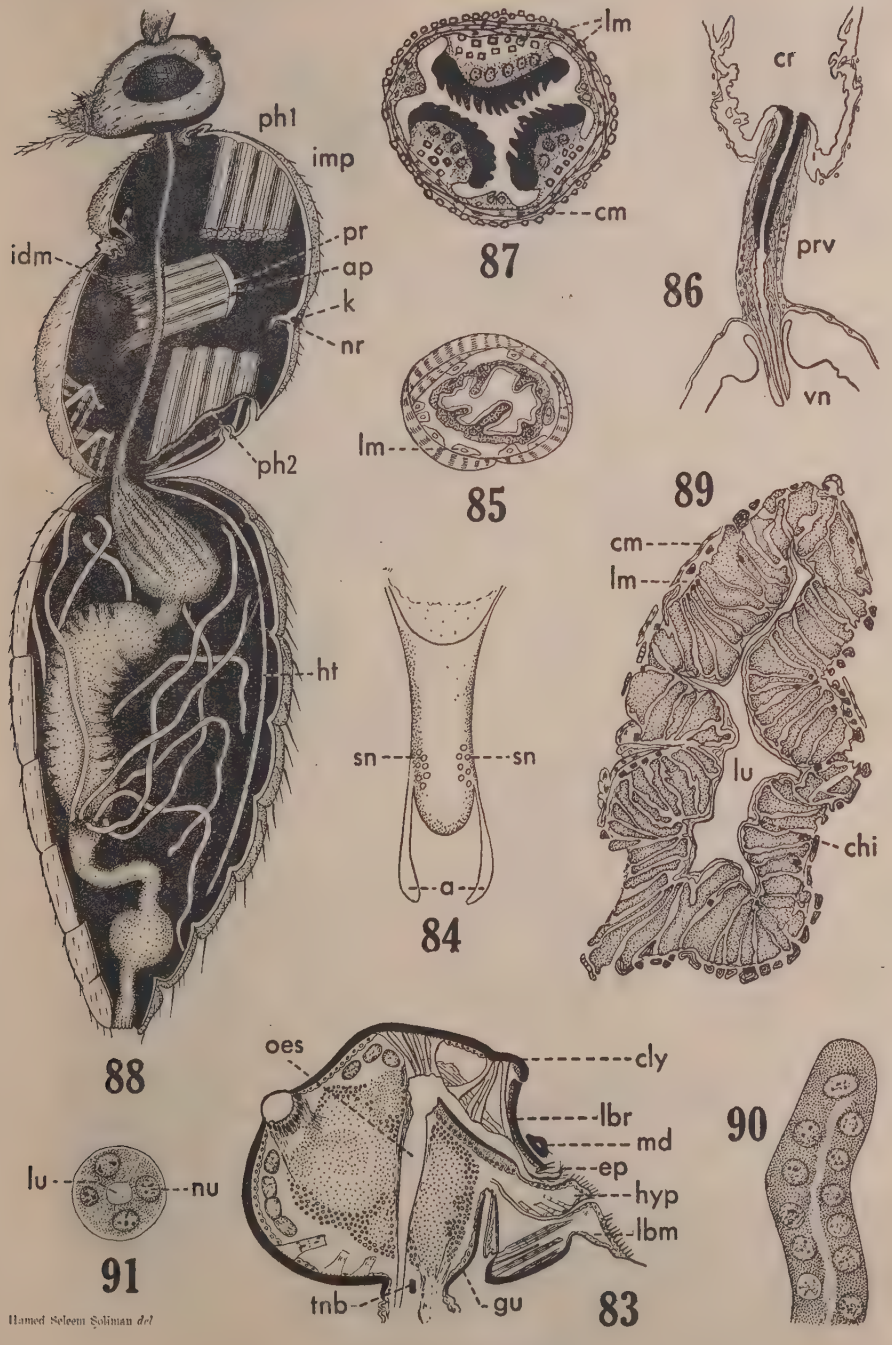

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Explanation of Plate XIII

Fig. 92. — Cross-section in pharynx showing the pharyngeal plate *php* and the greatly developed layer of cells under this plate (the section does not pass through the area where sensillae *sn* (Plate XII, fig. 84) are situated but is anterior to it. — × 640.

Fig. 93. — Cross-section in the pharyngeal plate passing through one of the sensillae: *nv*, nerve innervating the sensilla which has a thin dome-like covering membrane; *sn*, sensilla. — × 656.

Fig. 94. — Cross-section in ventriculus showing the darkly stained nidi or regenerating cells : *cm*, circular muscles; *epc*, epithelial cells of ventriculus; *lm*, longitudinal muscles; *nc*, nidi cell; *sh*, striated hem. — × 640.

Fig. 95. — Longitudinal section in junction of ventriculus and hind gut : *cm*, circular muscles; *chi*, chitinous intima lining hind gut; *hg*, hind gut; *lm*, longitudinal muscles; *mt*, malpighian tube; *pm*, periotrophic membrane; *omt*, opening of malpighian tube between ventriculus and hind gut; *vn*, ventriculus. — × 640.

Fig. 96. — Cross-section in rectum : *axc*, axial cavity; *rcp*, rectal pad. — × 240.

Fig. 97. — Cross-section in one of rectal pads : *axcv*, axial cavity; *chi*, chitinous intima; *hgw*, wall of hind gut; *syn*, syncytium. — × 640.

Fig. 98. — Longitudinal section through a rectal pad showing entrance of trachea : *chi*, chitinous intima lining the inside of the pad; *ci*, cell inclusions; *tr*, trachea. — × 640.

Fig. 99. — Slating cross-section near the anus showing the rectum behind the rectal gland : *chi*, chitinous intima; *cr*, cercus; *etc*, ectoderm or hypodermis; *ep*, epithelium of rectum. — × 440.

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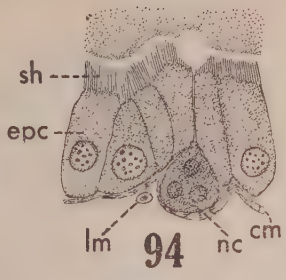

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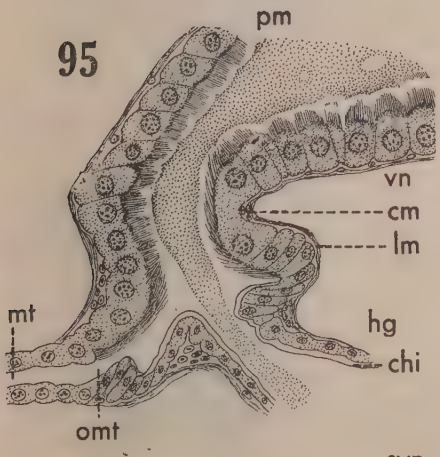

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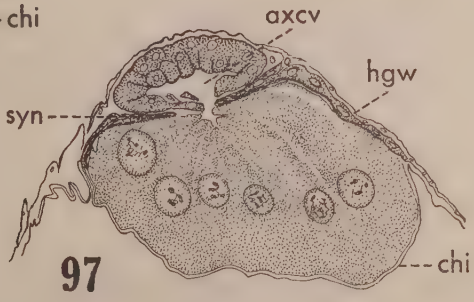

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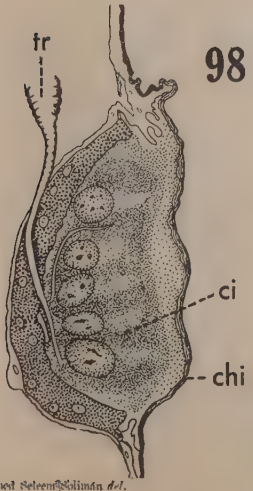

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Explanation of Plate XIV

Fig. 100. — Longitudinal section in « cardiac valve or invagination » : *bs*, blood sinus ; *chi*, chitinous intima ; *cm*, circular muscles ; *ep*, epithelium of proventriculus ; *lm*, longitudinal muscles ; *sph*, sphincter muscle ; *vn*, ventriculus. — × 640.

Fig. 101. — Longitudinal section in last abdominal ganglionic centre : *A*, female ; *B*, male. — × 240.

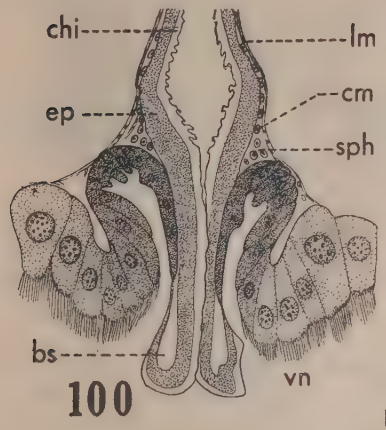
Fig. 102. — Frontal section passing through side of the head : *e*, compound eye ; *epo*, epiopticon ; *opt*, opticon ; *po*, periopticon. — × 168.

Fig. 103. — Abdominal spiracle (surface view, the anterior direction points towards the top of the page) : *bo*, stationary, chitinous hollow pocket ; *lv*, lever ; *o*, spiracular opening ; *per*, peritreme. — × 440.

Fig. 104. — Inner aspect of spiracle (*A*, while it is open ; *B*, while it is closed) : *bo*, stationary chitinous hollow pocket ; *cp*, chitinous piece ; *lv*, lever ; *o*, spiracular opening ; *och*, inner or occluding chamber ; *om*, closing muscles ; *opm*, opening muscles ; *per*, peritreme ; *tr*, trachea. — × 648.

Fig. 105. — Longitudinal section in spiracle (*A*, open ; *B*, closed) : *at*, outer chamber ; *bbo*, basis of *bo* of Figure 104 ; *cp*, chitinous piece ; *och*, inner or occluding chamber ; *tr*, trachea. — × 640.

Fig. 106. — Cross-section in the heart at sixth tergum : *am*, alary muscles ; *d*, diaphragm ; *fb*, fibres from branches of alary muscles ; *fc*, flat cells ; *ht*, heart ; *prc*, pericardial cells ; *us*, suspensorium. — × 640.



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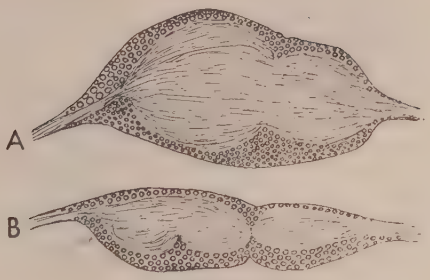

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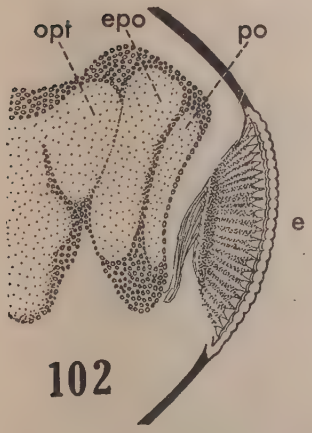

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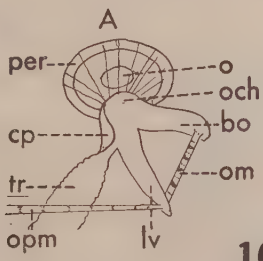

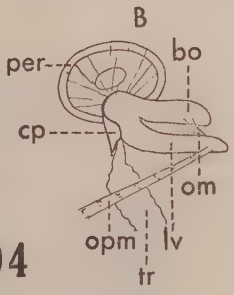

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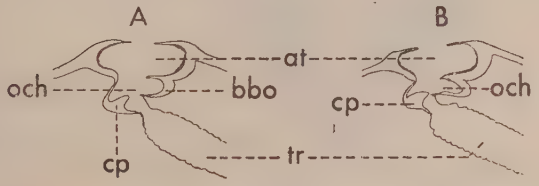

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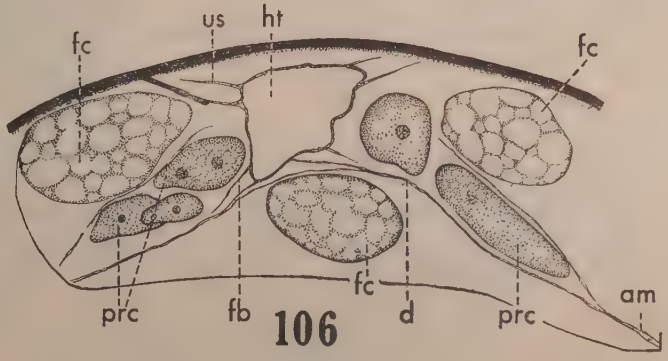

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Explanation of Plate XV

Fig. 107. — Cross-section in the wall of accessory or mucous gland : *cm*, circular muscles ; *epc*, tall epithelial cells ; *lm*, longitudinal muscles ; *pc*, peritoneal coat ; *sn*, secretion. — × 640.

Fig. 108. — Cross-section in accessory or mucous glands and vasa deferentia in their common peritoneal coat, just before the vasa deferentia open into the gland : *mg*, mucous gland ; *pc*, peritoneal coat ; *sn*, secretion ; *vd*, vas deferens. — × 320.

Fig. 109. — Longitudinal section passing through the opening of vasa deferentia into the mucous gland : *mg*, mucous gland ; *v*, lip or valve which closes the opening of the vas deferens ; *vd*, vas deferens. — × 240.

Fig. 110. — Male reproductive system (lateral aspect). The valves of the genital armature of left side and left side of basal piece are cut off : *a*, anus ; *bp*, basal piece ; *ejd*, ejaculatory duct ; *inv*, internal valve of left side ; *invp*, process of internal valve ; *mg*, mucous gland ; *p*, penis ; *pa*, genital aperture ; *rc*, rectum ; *t*, testes ; *vd*, vasa deferentia. — × 120.

Fig. 111. — Male genital armature (ventral aspect) : *bp*, basal piece ; *chs*, chitinous strut ; *exv*, external valve ; *inv*, internal valve ; *invp*, process of internal valve ; *p*, penis ; *pk*, keel of penis ; *sn*, sensillae ; *sz*, scleritisation in wall of penis. — × 240.

Fig. 112. — Male reproductive system in situ and genital armature (dorsal aspect) : *bp*, basal piece ; *ejd*, ejaculatory duct ; *exv*, external valve ; *inv*, internal valve ; *invp*, process of internal valve ; *p*, penis ; *V*, *VI* and *VII*, fifth, sixth and seventh abdominal segments. — × 92.

Fig. 113. — Cross-section in male genital armature passing at a level just anterior to the processes of the internal valve : *ejd*, ejaculatory duct ; *exv*, external valve ; *inv*, internal valve ; *m*, membrane ; *p*, penis ; *pk*, keel of penis ; *sz*, scleritisation in wall of penis. — × 232.

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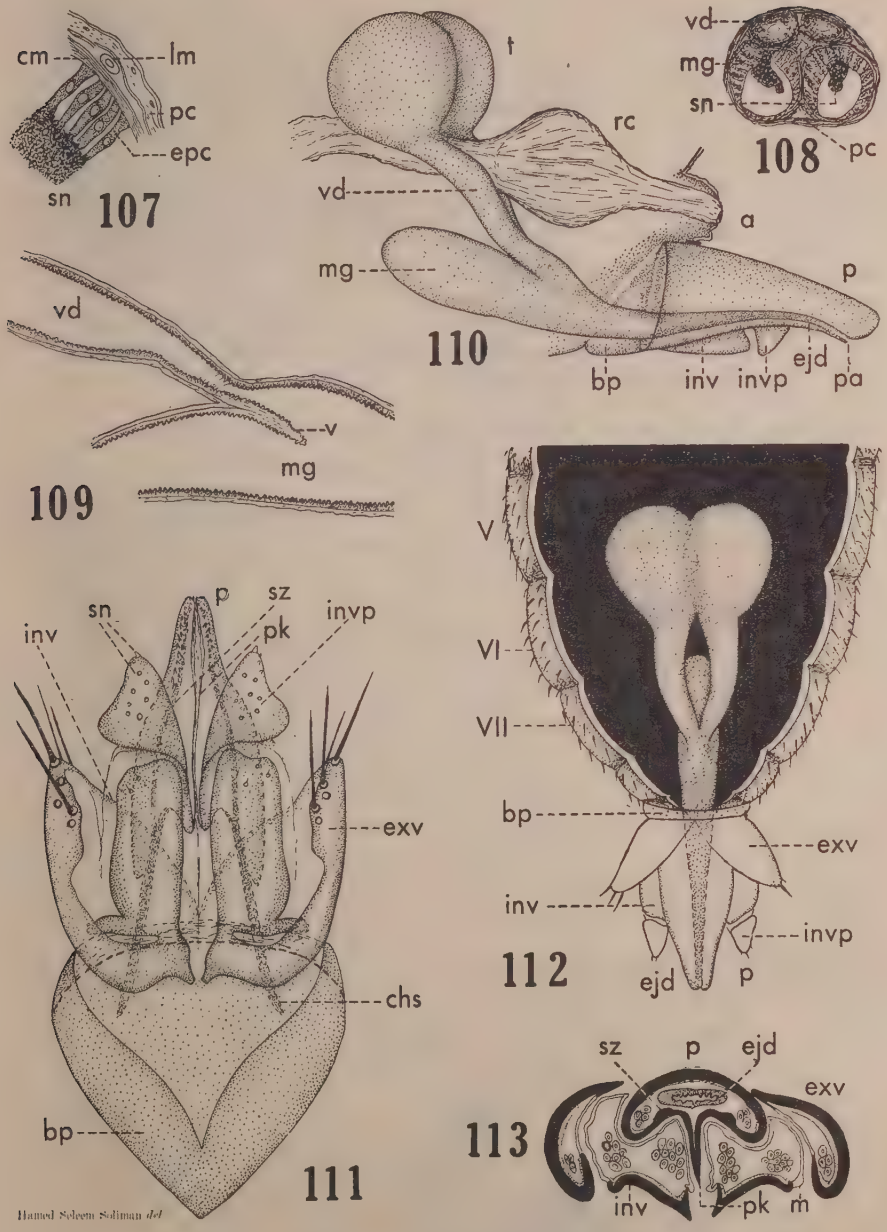
Plate XV



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Explanation of Plate XVI

Fig. 114. — Female reproductive system : *cx*, calyxes ; *ovd*, oviducts ; *spm*, spermatheca ; *tf*, short terminal or apical region ; *va*, vagina ; *vt*, vitellarium. — × 50.

Fig. 115. — Longitudinal section in part of vitellarium showing alternation of oocytes with nutritive cells : *fo*, follicular epithelium ; *nt*, nutritive cell ; *o*, oocyte. — × 440.

Fig. 116. — Cross-section in stylet sheath bulb showing entrance of common glandular duct *egd* : *sh*, stylet sheath ; *st*, stylets. — × 240.

Fig. 117. — Bulb of stylet sheath (dorsal view) : *sa*, interlocked arms of stylet and stylet sheath ; *sz*, scleritisation in latero-dorsal wall of bulb of stylet sheath. — × 224.

Fig. 118. — Ventral aspect of ovipositor and associated parts all lying in one plane (left furcal plate cut to reveal sensillae on oblong or inner plate) : *gd*, basis of palp-like appendage or guide of inner plate ; *op*, oblong or inner plate ; *or*, basal scleritised rib in oblong plate ; *ors*, lateral scleritised rib of oblong plate seen under quadrate plate ; *qp*, quadrate or outer plate ; *qr*, faintly scleritised rib on quadrate plate ; *qrs*, strong lateral rib of quadrate plate ; *sa*, interlocked arms of stylet and stylet sheath ; *shb*, bulb of stylet sheath ; *sn*, sensillae ; *tp*, fulcral or triangular plate ; *VIIIst* and *IXst*, eighth and ninth sterna. — × 168.

Fig. 119. — Cross-section in ovipositor passing through bulb of stylet sheath : *dl* and *dr*, left and right scleritised pieces in ventral wall of sheath ; *egd*, common glandular duct ; *hyp*, hypodermis ; *st*, stylet ; *sz*, scleritisation in bulb of sheath. — × 640.

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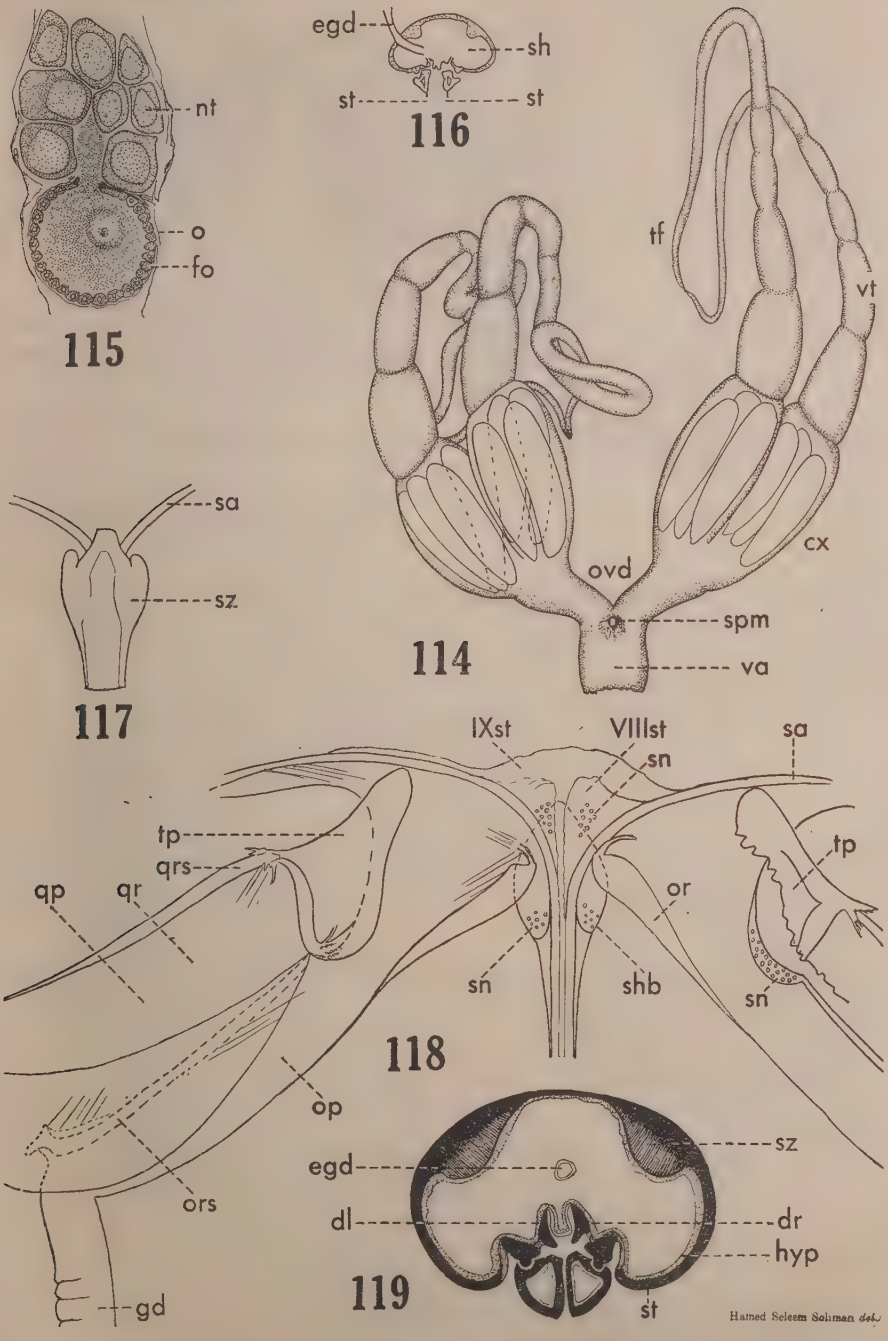

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Explanation of Plate XVII

Fig. 120. — Glandular acid tubes *gt* dissected apart from reservoir *r*. — × 48.

Fig. 121. — Sting apparatus (dorsal aspect) : *alg*, alkaline gland ; *cgd*, common glandular duct ; *qp*, quadrate plate ; *tp*, triangular plate ; *tr*, trachea ; *va*, vagina. — × 50.

Fig. 122. — Cross-section in part of the wall of alkaline gland : *chi*, chitinous intima. — × 240.

Fig. 123. — Cross-section in glandular tube of acid system : *chi*, chitinous intima ; *sn*, secretion. — × 240.

Fig. 124. — Cross-section in common glandular duct : *dw*, chitinous wall of the duct ; *lu*, lumen ; *ung*, unicellular gland. — × 720.

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Fig. 126. — A slanting longitudinal section in spiral showing attachment of longitudinal muscles : *lm*, longitudinal muscles ; *sr*, spiral ridges. — × 640.

Fig. 127. — Cross-section in reservoir : *lm*, longitudinal muscles ; *sn*, secretion. — × 440.

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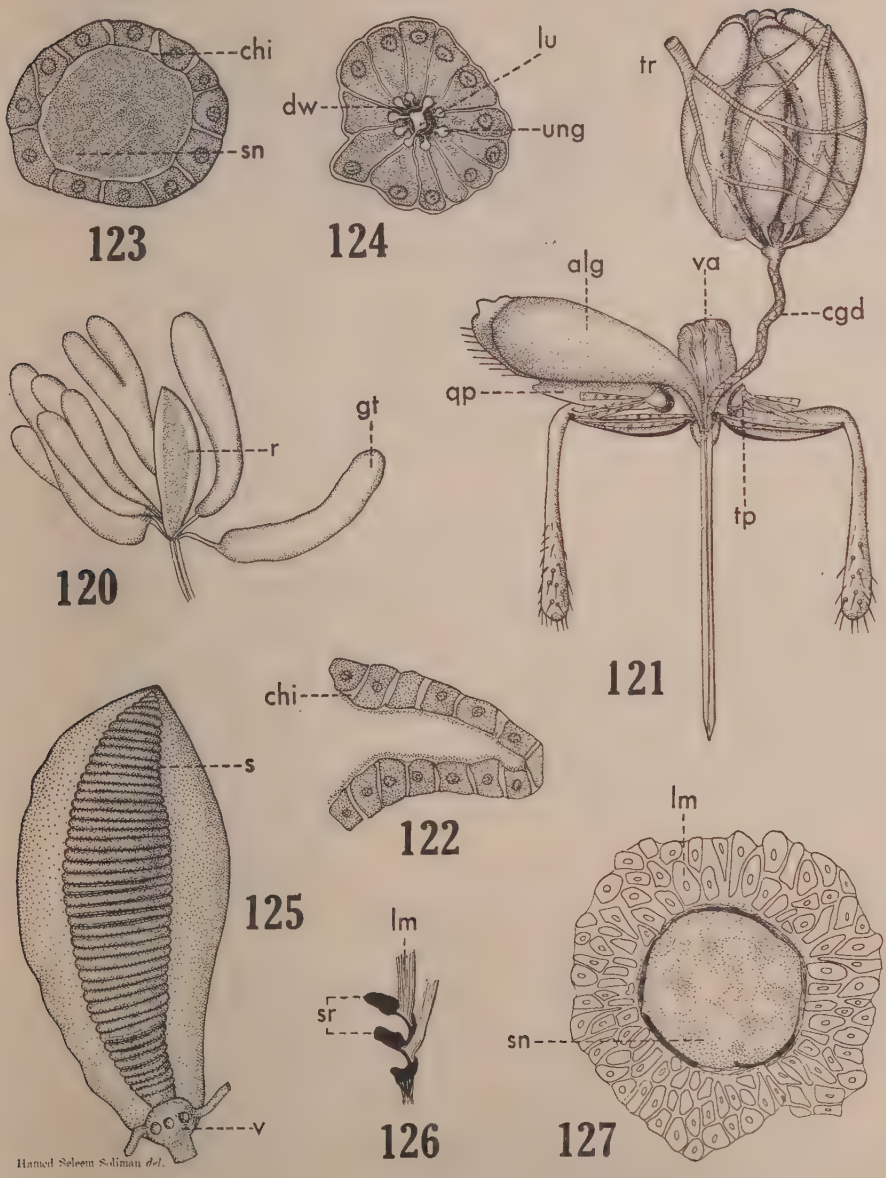

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Investigations into the Problem of Fly Control in Egypt"

(with 2 Text-Figures and Tables I-V)

by M. Hafez, B.Sc. (Hons.), M.Sc., Ph.D.,
Lecturer of Entomology,
Faculty of Science, Fouad I[st] University, Cairo.

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I. INTRODUCTION AND ACKNOWLEDGMENTS

The favourable temperature in Egypt, the presence and access of the breeding media of flies such as the different kinds of dung, refuse, etc., and the inadequate sanitary arrangements in the country such as the lack of the water carriage system of sewage and the prevalence of the conservancy methods instead, have greatly contributed to the extreme abundance of flies and have afforded very favourable conditions for fly propagation everywhere especially in the country.

It is easily conceivable that the more is the propagation of flies, the greater is their practical importance since in addition to their being terribly annoying to man and domestic animals their real danger centres in the fact that they are potential vectors of infectious diseases. Typhoid, paratyphoid, dysenteries, summer diarrhoea, conjunctivitis and ophthalmia are very com-

mon diseases in Egypt. The infection with the later disease is so serious that in some of the Egyptian villages, about 90 % of the whole population have suffered from it.

These evidences are sufficiently conclusive to demonstrate that an anti-fly campaign must necessarily form an integral part in any sanitary system especially in this country and that the problem of fly control must receive considerable efforts since it is very essential for the sanitation of the country and the improving of the living and hygienic conditions of the rural population.

Unfortunately, in our country this problem has not received the slightest attention or the least effort. The only account given on fly control in the Egyptian campain is that of Davidson (1918) who carried out some experiments in fly control while camping with military troops in the desert districts of Sinai near Suez. But the methods arrived at — though useful under such special circumstances — yet they cannot be advocated for general use under urban or rural conditions owing to their being impracticable. In other countries the problem of fly control has received intense investigation by some of the important and recent workers, namely Roubaud in France, Thomsen in Denmark, Lorincz and Makara in Hungary, Parisot and Fernier in Lorraine, Sergent in Algiers, Brain in Natal, Schuckmann, Bishopp, etc..

The present paper which is the outcome of about two year's work of extensive field observations and experiments in the country as well as in towns, may throw a light on the question of fly control under conditions prevailing in Egypt, and it is hoped that the results obtained may be of some interest to those working in the fly problem.

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II. THE COMMON FLIES, THEIR LOCAL DISTRIBUTION AND RELATIVE PRACTICAL IMPORTANCE

The most common flies which may frequent houses in Egypt and which may be the carriers of the causative organisms of certain of our most prevalent diseases are : *Musca vicina* Macq., *Musca vetustissima* Wlk., *Musca sorbens* Wied., *Musca vitripennis* Meig., *Musca tempestiva* Fallen, *Musca crassirostris* Stein, *Musca nebulo* Fabricius, *Stomoxys calcitrans* L., *Calli-*

phora erythrocephala Meig., *Muscina stabulans* Fallen, and *Lucilia sericata* Meig.

Musca vicina Macq.

Compared with the other species of flies which inhabit or occasionally frequent houses in Egypt, *Musca vicina* Macq., or the Egyptian common house fly, is by far the most abundant. It is the access of the breeding media on one hand and the favourable temperature in Egypt on the other hand which have contributed to the abundance and wide distribution of this species. Generally in the country this fly is more prevalent and abundant than in Cairo and the large towns, that is evidently attributed to the wide distribution of the breeding media such as the dung of the donkeys, sheep and goats in the country and to the almost unhygienic conditions under which the rural population lives. But in some localities in towns and near Cairo where pig breeding is common and pig sties or horse stables are not cleaned or carefully looked after, *Musca vicina* occurs in great abundance.

The house fly as annoying to man and as a vector of infectious diseases is generally recognised. With a view to practical control this fly stands first in importance, since it is responsible for the prevalence of certain of our most common contagious diseases especially in the country. The dissemination of disease mostly takes place by the mechanical transference of the disease germs. The fly constantly frequents and likes the substances used by man for food on one hand and excremental matter, purulent discharges and moist surfaces on the other. Should these different substances contain pathogenic organisms, the proboscis, body and legs of the fly are so densely setaceous that a great opportunity occurs with a considerable probability for the transference of the organisms from the infected material to either stuffs of food or such moist places as the lips, eyes, etc.. In other cases the germs are absorbed by the fly when feeding on infected matter, and again may be deposited by the proboscis since the fly has the habit of regurgitating the food. Infection from the anus may take place by means of infected faecal matter so promiscuously deposited as «fly specks». The fly is a potent factor in the dissemination of typhoid fever, diarrhoea, ophthalmia, tuberculosis, cholera, etc.. Some of these diseases, such as ophthalmia, are very widely spread in Egypt and the percentage of infected persons especially those of the rural population is very high, and that is directly ascribable to the flies which are the active and important agent in the transmission and spread of the disease.

The other Species of Musca

These are *Musca vetustissima* Wlk., *Musca sorbens* Wied., *Musca vitripennis* Meig., *Musca tempestiva* Fallen, *Musca crassirostris* Stein, and *Musca nebulo* Fabr.. They are generally less abundant than *Musca vicina* Macq., the common house fly, and some of them such as *Musca nebulo* Fabr., *Musca tempestiva* Fallen and *Musca crassirostris* Stein are rather widely distributed in Egypt. These species of *Musca* are almost met with in the country where they breed in cow and buffalo dung which constitutes the great bulk of dung on the Egyptian farms. In the region of Cairo and in the large provincial towns they are of limited distribution and occur in small numbers. Among these species of *Musca* there are *Musca sorbens* Wied. and *Musca vetustissima* Wlk. which may occur near the desert.

As to the dissemination of diseases by these flies it is possible that some of the common diseases in the country such as ophthalmia, infantile diarrhoea, etc., are transmitted by these flies by mechanical transference. In Mesopotamia *Musca sorbens* Wied., according to Patton, is an important transmittor of the organisms which cause the eye diseases. In addition to their danger as vectors of infectious diseases, they are especially annoying to man by hovering around and finding their way into one's eyes, nose, mouth, etc.

Stomoxys calcitrans L.

This blood-sucking fly is common and is widely distributed, occurring especially in the country in the early summer and autumn. In towns it is not commonly met with and sometimes it is very rare. The reason of its common occurrence in the country is the fact that the fly belongs to the byre where it breeds in cattle dung, especially that of calf and cow. When not sucking blood from the cattle, it will be found on the walls and ceilings. Sometimes it occurs in large numbers in horse stables especially when the cattle is out of the byre. In sheep and goat houses this fly is of uncommon occurrence. The fly is naturally an outdoor species, but sometimes frequent houses when it is usually found on the windows, verandas and similar places and inflicts very irritating bites. In the country, near the water canals where the cattle are used to drink, the fly is seen in abundance.

From the practical point of view this species is very important since it is a terrible tormentor of cattle and horses and a possible vector of infectious diseases.

Calliphora erythrocephala Meig.

This fly is an out-door species but it is frequently met with in houses in search of material upon which it deposits its eggs. Generally it is more common in the country than in towns. In the country, owing to inadequate sanitary arrangements, heaps of human excrement are of abundant occurrence and these afford a suitable breeding medium for the fly. Also the carrion and the dead animals in which the fly cheifly breeds are very common in the country. In certain localities in Cairo (observed in Demerdash, 1939), where human excrement is collected in heaps, this fly is of abundant occurrence.

From its habits of frequenting faeces it is not improbable that it occasionally may carry intestinal bacilli on its legs or body or internally, and thus transmit infection. Its flesh-feeding habits may also render it liable to carry the bacilli of anthrax if it comes into access to infected flesh.

Muscina stabulans Fallen

This fly occurs very commonly in houses where it feeds on the house refuse. It is widely distributed in the country where the breeding media such as cattle and horse dung and heaps of human excrement are quite available. Near Cairo, where certain farms exist, the fly is of abundant occurrence in the farmers' houses, especially in the early summer and autumn.

The habits of this species which lead it to frequent dung, human faeces and decomposing animal or vegetable matter, render it a potential disease-carrier. Diarrhoea (Banks, 1912) may be transmitted by this species.

Lucilia sericata Meig.

This species is an out-door fly. It is rarely seen in houses. It is common in the country especially in the farms and farmer's houses where dung and exposed human excrement are very common. The flies usually prefer carrion and dead animals as a breeding and feeding medium. In Cairo and in large provincial towns they are of uncommon occurrence, only in certain localities outside Cairo (observed in Imbaba and Qubba Gardens, 1939) they are frequently seen. This species, owing to its filthy habits, may be a carrier of the causative organism of some diseases.

III. THE BREEDING MEDIA OF THE COMMON FLIES

When tackling the problem of fly control it is obvious that a sound and perfect knowledge of the breeding media and places of the fly is undoubtedly the most important question which the investigator has to solve. Therefore, a long time was devoted to the study of the different breeding media of

Musca vicina Macq., the Egyptian common house fly, as well as the other species of *Musca*, *Stomoxys*, *Calliphora*, *Muscina* and *Lucilia* since they are of common occurrence and their practical importance as possible disease carriers and as annoying to man and domestic animals is easily recognised. This may help in a better understanding of the fly problem and may throw a light on its practical control. The study and observations have been made in the country as well as in Cairo and several provincial towns. In addition to the field observations, oviposition experiments have been carried out in the laboratory to test the power of attraction of different kinds of breeding media for these different flies.

1. The breeding media of Musca vicina Macq.

Reviewing the literature it seems that Patton (1933) was the only author to refer to the breeding media of this species. He stated that it lays its eggs in large collections of cow dung. Patton's statement differs from the conclusions arrived at by the present author regarding the chief breeding places of this species.

Observations in the country

Some typical cases may be quoted:

April (1939), Sharabas.—A big farm was visited. A large number of cows, buffaloes and calves were kept. Their dung is accumulated in large heaps in a place near the byre, and when these were examined, they were found to contain no larvae of *Musca vicina* Macq.. Also no adult flies were seen to frequent the dung. In another place in the farm a mixture of cow, buffalo and donkey dung was accumulated, and when searched a few larvae were found.

April (1939), Zarka.—A stable that served most exclusively for donkey keeping. About thirty donkeys were kept at night in the stable. As the stable was not cleaned or carefully looked after, the donkey dung was accumulated on the floor and together with the urine of the donkeys and litter, a soft bedding of several inches thick was produced on the floor of the stable. When this bedding was examined it was found to teem with a large number of larvae of *Musca vicina* Macq. The adult fly was also seen in abundance, and numerous batches of eggs were also found.

April (1939), Ibadeih.—A house that served mainly for sheep and goat keeping. About 300 of these were kept at night only, being at pasture by day. The house was not cleaned except at intervals of about three weeks or even more and thus the huge amount of dung was allowed to stay a long time without being removed. Examination of this dung showed the abundant

occurrence of *Musca vicina* larvae. A great number of these occurred near the corners and side walls of the stable. The adult fly was found in prodigious numbers.

May (1939), Shrimsah.— Outside this village there was a large area in which heaps of human excrement were accumulated. The heaps grow gradually through daily addition of fresh excrement. Careful search in these heaps clearly showed that a tremendous number of larvae of *Musca vicina* is found. Most of larvae occurred near the surface layers about two inches deep. Adult flies were found in abundance hovering on the heaps of excrement.

May (1939), Shrimsah.— A farmer's house was visited. About 100 fowls and several ducks were kept in the house. In a corner, a heap of fowl dung mixed with some decomposing vegetable matter was examined and found to contain a large number of the house fly larvae. Several batches of eggs were also seen.

Observations in towns

A few typical cases may be quoted :

May (1939), Mansourah.— In a horse stable owned by some private people about 23 horses were kept, and their droppings being not all removed, some were accumulated on the floor of the stable. Fresh litter however is supplied frequently which absorbs the urine and affords a dry and soft couch to the horses. The result is that the floor of the stable is provided with a thick layer of compact litter mixed with dung and wetted with urine and only the surface being fairly dry. In this thick layer the larvae of *Musca vicina* were found in great abundance especially in the deepest regions where more humidity was available.

May (1939), Abbassia.— A very large horse stable owned by the army was visited. It contained about 120 horses. The stable was cleaned daily and the dung was collected in one of the corners. The cemented floor of the stable was washed several times per day and a poisonous spray (phenol) was frequently used. For this reason flies were rarely seen. The dung accumulated in the corner was examined and was found to contain no larvae, but a few batches of eggs were met with.

May (1939), Cairo.— A large pig sty which served for keeping about 200 pigs was visited. The place was very dirty and accumulations of pig dung of several days old were scattered in all parts of the sty. When the dung was examined it was found to contain very prodigious numbers of *Musca vicina* larvae. Numerous batches of eggs were found on fresh dung. The larvae seemed to prefer the deepest layers of the dung and in several cases were seen on the surface of the soil just below the dung mass where lower temperature and favourable humidity were available.

September (1939), Demerdash-Cairo.— In this district the drainage systems and sanitary arrangements are quite inadequate or even not available. There are no water closets of any kind in the houses. Therefore there is a large area on to which human excrement is accumulated. Careful search showed the presence of numerous larvae of *Musca vicina*. The adult flies were seen on the excrement in large numbers.

Results of observations

A. In the country

(1) Repeated observations have clearly demonstrated that under Egyptian rural conditions the house fly (*Musca vicina* Macq.) will mainly breed in donkey dung mixed with litter in donkey stables. Owing to the wide distribution of donkeys in the country, being the chief beast of burden and means of transport, there are special houses either in the farm or in the village for donkey keeping. Most of these houses are not cleaned or carefully looked after, therefore donkey dung is accumulated on the floor of the stable and as the animals trample about, the dung together with litter, food remains and urine is made into a more or less continuous layer which may be a foot or more in thickness and afford a soft bedding for the donkeys. In this bedding the larvae and eggs are found in greatest abundance. Adult flies are seen in small numbers inside the stables.

(2) Another breeding medium which in my belief plays an important part in the fly production in the country is sheep and goat dung. Sheep and goats are very abundant in the country, and at night they are sheltered in large houses in each of which few hundreds may be found. Large masses of their dung are accumulated on the floor of the house and in these masses which are allowed to stay a long time without being removed the larvae of the house fly are found in abundance. The larvae seem to prefer the regions near the walls and corners of the stable.

(3) It is interesting to know that thorough investigations on farms have shown that cow and buffalo dung which constitute the great bulk of dung on farms do not attract the ovipositing flies except in very rare cases. In large farms cow, buffalo, donkey, calf, sheep and goat dung are all collected together and accumulated in large heaps. These heaps which grow gradually through daily additions may attain a considerable size and finally at the end of several months they are utilised as manure. These heaps especially their upper layers usually teem with a very large number of house fly larvae.

This indicates that cow or buffalo dung when mixed with other sorts of dung such as that of calf or donkey, etc., may be a favourable breeding medium for the common house fly.

(4) Another breeding medium which is not less important than donkey dung is the human excrement. In the greatest majority if not all of the Egyptian villages the water carriage system of sewage is completely lacking, and instead there are the conservancy methods of which cesspits are the more prevalent in the country houses. The cesspit is in the form of a ditch of about two metres deep, and when this is filled with excrement, it is emptied onto large heaps outside the village. In other cases these cesspits are lacking altogether from the houses and then faeces are dropped in pans and emptied when filled and so forth, thus large accumulations of fresh and few days old excrement are found in an extensive area near the village. These accumulations harbour a very great of fly larvae and to a very great extent responsible for the production of the house fly in the country. Adult flies are usually seen in great abundance on the excrement. The temperature generated inside is about 30° C. which is sufficiently favourable for development. Scattered small masses of excrement in roads and subways in the villages, are usually of no importance as breeding media since they dry up too rapidly.

(5) On the other hand fowl dung in some cases plays a part in the propagation of the house fly in the country. Fowl breeding is a prevailing habit among farmers, and a large number of fowls and other birds are kept usually in the farmer's house. The dung of these animals is accumulated and the place being not cleaned or looked after the dung is left long enough to allow the oviposition of the flies. Careful examination of this dung have shown that it contains numerous larvae of *Musca vicina* Macq. In most cases fowl dung is mixed up with decomposing vegetable and animal matter and that mixture affords a favourable breeding medium. Scattered fowl dung does not attract the ovipositing flies, and it dries up very rapidly.

B. In towns

(1) Thorough investigations in several provincial towns and in the region of Cairo have definitely demonstrated that the chief breeding medium of *Musca vicina* Macq. and which is to a great extent responsible for the fly production is horse manure. A great number of the horse stables are owned by private people. The stables are not cleaned except at intervals of weeks or even of months and fresh litter and food remains are supplied frequently which absorbs the urine and affords dry and soft bedding to the horses. The result is that the floor of the stable is covered with a thick layer of compact litter mixed with dung and wet with urine, only the surface being slightly dry. In this bedding larvae of the house fly are found in great abundance especially in the deep layers where more humidity and lower temperature

are available. The temperature of this bedding (30 to 35° C.) is very favourable for the ovipositing females. In the corners of the stable, accumulations of horse dung of few days old which usually harbour a large number of larvae frequently occur.

The stables of the government especially those of the army are also an indirect source of fly production and propagation. A very large number of horses are kept in these stables. The horse dung is usually accumulated in one of the corners. Sanitary measures are taken in these stables by cleaning the floors and using insecticides, and by the daily removal of the dung accumulations from the stables. The dung is loaded in carts and sold to gardeners to be utilized as manure. The real danger remains in these accumulations of horse dung which are taken by the gardeners and left in the open to ferment. Owing to the fact that the dung is loose and not closely packed, fermentation takes place slowly, and in about 10-15 days it is more or less complete. Long before this time is elapsed the life cycle of the common house fly is completed. Under favourable food and temperature conditions which are available in these accumulations of horse dung the life cycle of *Musca vicina* Macq. usually does not exceed six or seven days in the early summer and autumn. Also the temperature of the surface of those dung heaps are favourable enough (about 30 to 35° C.) to attract the ovipositing females. It should be pointed out that these heaps of dung supplied daily by the government stables in which about 400 horses are kept in Cairo only are together of a very large size. Inquiry was made in these stables in Cairo and it has been found that not less than 10 carts (the chamber in which the dung is placed in each cart is about one cubic metre in size) are loaded nearly every day from the different stables of the government. Therefore it is obvious that these very large masses of horse dung left in the open afford a very favourable medium for oviposition and development of the flies.

Single horse droppings scattered on roads are not attractive to the egg laying females. Evidently they dry up too rapidly and are in addition broken up by birds.

(2) As regards pig dung it has been clearly shown from my observations that it is highly favoured as a medium for egg laying. Its power to attract the ovipositing flies is much greater than that of horse manure. It has been also noticed that not only the fresh dung which attracts the egg-laying females, but if the flies are checked in their access to the fresh pig dung they are able to oviposit in older dung, at any rate in dung 4 days old and most likely also in still older dung, as pig dung will retain its original humidity, consistency, specific odour, etc., longer than horse manure, partly at least owing to the fact that fermentation takes place more slowly in this dung than in the horse dung. Lorincz and Makara (1935) have also shown

that the fly breeding capacity of the manure diminishes with the progress of fermentation, but that pig manure retains its capacity for fly breeding much longer than do horse manure. But although the pig dung is the most favourable breeding medium of *Musca vicina*, yet its practical importance and responsibility for fly propagation is very limited owing to the fact that pig breeding is not common in Egypt and the distribution of pigs is restricted to a few localities. In these localities pig sties in which a large number of pigs are kept are found. The sties are mostly not cleaned and the dung is accumulated on the floor, sometimes the dung is collected and placed in the open in a manure pit and this afford a favourable breeding place for the flies.

It may happen in some sties which are carefully looked after that the flies will oviposit partly on the straw of the bedding and partly on small remnants of dung in corners and hidden places which are not cleaned frequently. These observations which reveal the strong attractive power of pig dung as a breeding medium and which clearly demonstrates that — if pigs are widely distributed in Egypt — pig dung will be responsible for fly propagation, are in agreement with those made by Thomsen and Hammer (1936) on Danish farms and Lorincz and Makara (1935) on Hungarian farms.

(3) Another breeding medium of flies which is not less important than the other media is the house refuse. In some cases this refuse including decomposing vegetable and animal matter is collected and accumulated onto large heaps or public dumps placed in the open and these on examination have been found to contain very numerous larvae. But smaller masses of domestic organic refuse are not a favourable breeding medium since they dry up too rapidly and are also broken up by birds and scavengers.

Oviposition experiments

It is now obvious from the observations made in the country as well as in towns that the Egyptian common house fly breeds mainly in definite kinds of manure. In order to acquire a possible confirmation to my direct observation and and to test the power of attraction of different kinds of breeding media to the ovipositing flies, several experiments have been carried out during which the flies were given the option of seven kinds of dung. These were donkey dung, sheep and goat dung, cow dung, human exrement, pig dung, buffalo dung and horse manure. The dung was brought fresh from farms, stables, privy middens, etc., and placed in special wooden frames in the open. Fourteen frames were used two for each kind of dung. The dung was left exposed for oviposition about six hours or more, and then taken and distributed in large vessels (each is about 10 inches in diameter and 6 inches in height) which were covered with muslin. When the adult

house flies emerged they were collected, preserved and identified. This procedure was repeated several times and in each time the flies from each kind of dung were counted.

The results of the individual experiments (see Table I) clearly demonstrate the difference between the power of the individual kinds of manure — expressed in number of hatched individuals — to attract the ovipositing flies. They also show good agreement with the results of direct observation. Therefore it may be safe to definitely consider that horse and donkey dung are the chief breeding media of *Musca vicina* Macq. in Egypt and if pig dung is in access its power of attraction to the ovipositing flies exceeds that of horse and donkey dung.

Human excrement also plays a very considerable part as a breeding medium. Sheep and goat dung comes next to human excrement. Cow and buffalo dung is an unfavourable breeding medium and as rule does not attract the house fly for oviposition.

2. The breeding media of some other species of Musca

It seems from the review of literature that no important account of the breeding places of other species of *Musca* (*vetustissima* Wlk., *sorbens* Wied., *vitripennis* Meig., *tempestiva* Fallen, *crassirostris* Stein, and *nebulo* Fabr.) has been given by previous workers. Patton (1933) gave very short remarks on the breeding media of these species.

Observations in the country

Some typical cases may be mentioned :

April (1939), Dakahla.— A large farm was visited, the dung of cows, buffaloes was intended to be utilized as manure and therefore it was accumulated in heaps which grow gradually through daily additions of fresh dung. One of these heaps of about four days old was examined. It was found to contain a very large number of larvae of *Musca vitripennis* Meig. The larvae were more abundant in the surface and the middle layers of the heap. A second heap placed near the first and which was about eight days old and composed of a mixture of cow, buffalo, calf and little horse dung was examined. It was found to harbour numerous larvae of *Musca tempestiva* Fallen, about 24 larvae of *Musca crassirostris* Stein near the surface and several pupae of *Musca tempestiva* Fallen and *Musca crassirostris* Stein. The pupae mostly occured near the sides and the base of the heap.

April (1939), Kanatir el Khairieh.— A small farm was visited. The dung was not utilized as manure, but as fuel when it dries up. Cow and buffalo dung was collected during the day time and placed near the byre until sun-

TABLE I

Musca vicina Macq. : Oviposition experiments

DATE OF EXPERIMENT	DONKEY DUNG		SHEEP AND GOAT DUNG		COW DUNG		HUMAN EXCREMENT		PIG DUNG	
	frame 1	frame 2	frame 3	frame 4	frame 5	frame 6	frame 7	frame 8	frame 9	frame 10
5.8.1939	238	713	149	614	3	—	210	516	1632	2015
15.8.1939	1210	510	812	640	—	—	744	803	3146	1553
22 8.1939	381	879	210	79	—	—	139	375	826	385
2.9.1939	1370	725	618	823	7	—	813	933	2091	1458
12.9.1939	2003	819	851	713	—	—	1301	805	323	2537

BUFFALO DUNG		HORSE DUNG		Total number of individuals of *Musca vicina*						
				DONKEY DUNG	SHEEP AND GOAT DUNG	COW DUNG	HUMAN EXCREMENT	PIG DUNG	BUFFALO DUNG	HORSE DUNG
frame 11	frame 12	frame 13	frame 14							
—	—	318	931	951	763	3	726	3647	—	1249
—	1	2130	751	1720	1452	—	1547	4699	1	2881
—	—	461	315	1260	289	—	514	1211	—	776
—	—	1023	911	2095	1441	7	1746	3549	—	1934
—	3	3212	1214	2822	1564	—	2106	2860	5	4426

set when it was taken to the farmer's house. The dung dropped at night was taken on the next day. Sometimes the dung may be left in the farm about two days. The farmer adds some water to the dung which is then made into small flat discs of about two or three centimetres thick and then placed in the sun to dry. Two or three days in summer and five or six days in winter are sufficient for the complete dryness of these discs which are afterwards ready for use as fuel. Careful examination of some freshly made dung discs resulted in the presence of no larvae, only batches of eggs being found. In other cases larvae of *Musca vetustissima* Wlk., *Musca vitripennis* Meig. were seen in the discs but most of them were observed to bore downwards through the substance of the disc and escape towards the surface of the soil on which the discs are left to dry.

Observations in and near towns

These typical cases may be quoted:

May (1939), Qubba Gardens (Cairo).—A modern farm in which a large number of cows, buffaloes, calves and three horses were all kept in different houses. The dung of these animals was collected and placed all in a manure pit.

Every two days the dung accumulated is removed from the pit and loaded in carts and sold for utilizing it as manure or fuel. Just before the removal of the dung from the pit I examined it and found that it teemed with prodigious numbers of larvae of *Musca tempestiva* Fallen, and *Musca vitripennis* Meig. Adults of these species and *Musca nebulo* Fabr. were also seen in abundance. In a near place a mass of pure horse dung of about two days old—probably forgotten by the farmer—was seen and examined. It was found to contain no larvae.

May (1939), Faraskour.—A stable that served most exclusively for sheep and goat keeping. A large number (about 130) of these animals were kept at night. Their dung was not removed except at long intervals and therefore the floor of the stable was provided with a thick layer of dung mixed with straw and litter. When this layer was examined numerous larvae of *Musca vitripennis* Meig. were found. Next to the stable there was a shed in which two donkeys were kept. There was a large mass of their dung which when examined was found to contain no larvae at all. About a hundred metres from the stable a small pig sty containing 15 pigs was visited. The dung of the pig was searched but no larvae were met with, only two adults of *Musca crassirostris* Stein were observed on the dung.

May (1939), Demerdash.—An area onto which accumulation of human excrements were placed was visited. Adult *Musca sorbens* Wied. were seen in abundance on the excrement and the larvae of this species and those of *Musca tempestiva* Fallen abundantly met with inside the faeces.

Results of observations

My observations in the country as well as in the region of Cairo and several provincial towns have clearly shown that the most favourable breeding media of *Musca sorbens* Wied., *vitripennis* Meig., *tempestiva* Fallen, *crassirostris* Stein, *nebulo* Fabr. and *vetustissima* Wlk. are the cow and buffalo dung. Other kinds of dung though less favourable as breeding media, yet in several cases they play a considerable part in the breeding and propagation of flies. On farms the greatest bulk of dung accumulated is that of buffaloes and cows. In large farms the dung is usually utilized as manure, while in small farms it is dried up and then utilized as fuel. In the former case the dung of cows, buffaloes on the farms is accumulated in heaps, in some farms where donkeys or horses are present, then the dung of these animals is also added to the heaps. These heaps may attain a large size and according to observation and investigation they harbour numerous larvae inside and they also attract the flies for oviposition. The temperature on the surface and inside of the heaps is very favourable. Repeated measurements of temperature in such manure heaps have shown that it was 30 to 35° C. in May. In a few cases the dung accumulations take the form of stacks occupying an extensive area. This generally takes place in large and rich farms which keep an enormous number of cows, buffaloes, donkeys and horses, etc.. The dung of these animals is stacked, the stack may reach five metres high and the surface area about two hundred square metres. The surface layer of the stack which is kept moist by fresh daily additions of dung attracts the ovipositing flies in large numbers and the temperature is also sufficiently favourable for the completion of development.

In the small farms the dung is made use of as fuel and therefore it is not allowed to stay a long time as in the case of large farms. The boys in the farms collect the droppings of the cows and buffaloes and pile them in a place near the byre. In about two or three days the quantity of the accumulated dung attains a moderate size, then it is mixed up with some water and made into circular flat discs, each of about two or three centimeters thick, and these left to dry in the sun. In about two or three days in summer and five or six in winter the dung disc dries completely and becomes ready for use as fuel. The dung before this process usually contains numerous larvae and batches of eggs. These may be also found in the discs and until the discs become completely dry some of the third stage larvae present may succeed to develop and pupate. That was demonstrated by the presence of pupae just below the discs on the soil. In other cases the dung dropped by the animals during the day time is collected and left till the next morning when the dung dropped at night is added to it, thus the dung on these farms is allowed to stay a short time for the oviposition of flies. But in this case

it is obvious that the eggs or first stage larvae that may be present in dung fail to complete development owing to the fact that the discs dry in a short time especially in summer.

As regards the dung accumulated in the cow and buffalo stables it is to my mind of more importance from the practical point of view than that accumulated on farms, and is responsible for the production of large numbers of flies in the country. The conditions in these cow stables are rendered more favourable for development by the presence of suitable temperature and humidity. These stables are not cleaned except at long intervals, and not all the dung is removed but a part of it is left on the floor of the house to afford when mixed with straw and food remains a soft bedding for the buffaloes and cows. The bedding is very attractive for the egg-laying females. The removed dung is usually accumulated on the roof of the house, and then made into discs which will be left in the sun to dry. Larvae which may be present in this dung may or may not succeed to complete development.

Thorough investigations have clearly demonstrated that horse manure may be a favourable breeding medium for some species only, namely *Musca sorbens* Wied. and *Musca tempestiva* Fallen. The manure is rendered more attractive for ovipositing flies when mixed with cow, buffalo or calf dung. That frequently takes place in the region of Cairo and provincial towns where several horse stables are of common occurrence.

Sheep and goat dung has been found to play an important part in the propagation of these flies. This dung is quite available in large quantities owing to the wide distribution of sheep and goats in the country where several houses are fitted most exclusively for their keeping. Such houses or stables are not carefully looked after and the dung of the animals is intentionally left on the floor to serve as a bedding for goats. This bedding usually contains an enormous number of larvae the development of which may be accelerated by the favourable temperature (30 to 38° C.) and humidity available in the stables.

As regards human excrement it has been found to be attractive to the ovipositing females of most species of *Musca* especially *Musca sorbens* Wied. and *Musca tempestiva* Fallen which seem to highly favour this substance as a breeding medium for their larvae have been found several times in large numbers inside the excrement. The part played by human faeces in the breeding and propagation of flies is more considerable in the country as well as in a few districts in towns where huge accumulations of excrement occur in the open owing to inadequate sanitary arrangements and drainage systems.

The other kinds of dung, namely pig, donkey and fowl dung, have been found to be of no importance as breeding media. The adult flies may be attracted to the dung probably for feeding and not for laying eggs. Also the

TABLE II

Oviposition experiment : 5.VIII.1939, Abbassia

SPECIES	DONKEY DUNG		SHEEP AND GOAT DUNG		COW DUNG		HUMAN EXCREMENT		PIG DUNG
	frame 1	frame 2	frame 3	frame 4	frame 5	frame 6	frame 7	frame 8	frame 9
Musca sorbens	5	—	105	96	672	231	86	101	—
Musca vitripennis	—	13	232	135	379	850	30	260	—
Musca tempestiva	—	—	—	—	231	536	38	130	1
Musca crassirostris	4	—	23	7	52	91	—	16	—
Musca nebulo	—	—	—	—	333	185	—	120	—
Musca vetustirsima	—	—	12	—	41	138	—	16	—

BUFFALO DUNG		HORSE DUNG		Total number of individuals emerged						
				DONKEY DUNG	SHEEP AND GOAT DUNG	COW DUNG	HUMAN EXCREMENT	PIG DUNG	BUFFALO DUNG	HORSE DUNG
frame 11	frame 12	frame 13	frame 14							
988	698	230	40	5	201	903	187	—	1686	270
1381	713	142	99	13	367	1229	290	—	2094	241
333	181	78	136	—	—	767	168	1	514	214
21	39	31	—	4	30	143	16	—	60	31
653	781	—	—	—	12	518	120	—	1434	—
138	230	—	—	—	—	179	16	—	368	—

flies show a strong repugnance of egg laying in kitchen refuse. Repeated search for larvae or eggs in this substance mostly resulted in the presence of none.

Oviposition experiments

These experiments have been carried out in conjuction with those of *Musca vicina* Macq. The result of one of the typical experiments is given in Table II. It clearly shows that the power of attraction of cow and buffalo dung for the ovipositing flies of *Musca sorbens* Wied., *vitripennis* Meig., *tempestiva* Fallen, *crassirostris* Stein, *nebulo* Fabr. and *vetustissima* Wlk. is by far much greater than that of other kinds of dung. Horse manure, sheep, goat dung and human excrement seem according to the numbers of hatched individuals that they attract the egg-laying females nearly in the same proportional degree. Other breeding substances such as pig dung and donkey manure are generally not attractive to the ovipositing flies.

3. The breeding media of Stomoxys calcitrans L.

The review of literature reveals that no studies on the biology of *Stomoxys calcitrans* L. have been made in Egypt. In Europe, no important account on the biology of the fly with a view to practical control has been given except that of Thomsen and Hammer (1936).

Newstead (1906) in his study of the life history of *Stomoxys* did not find larvae or pupae of *Stomoxys* in cattle dung in fields or heaps of manure.

Portschinsky (1910) states that *Stomoxys* breeds chiefly in horse manure around stables, and not in cattle dung in similar places. He observed that no oviposition takes place in horse or cattle dung in open fields.

Mitzmain (1913) in his account of the bionomics of *Stomoxys* stated that he had observed egg-laying in horse dung.

Hindle (1914) stated that stable manure and decomposing vegetable matter constitute the chief breeding media of *Stomoxys*.

Wilhelmi (1917) observed that *Stomoxys* did oviposit in cattle dung. He is more inclined to believe that oviposition occurs mainly in the byre, and the eggs or young larvae as they are transferred with the dung to the manure heap, may continue and complete development.

Bishopp (1920 and 1931) in his very important account of the stable fly stated : « Horse manure has been considered the normal breeding medium for this pest. Investigations made during the outbreak in 1912 showed clearly, however, that the vast majority of the flies bred out in straw stacks, and investigations made around stables and barns indicate that while the fly breeds in pure horse manure, it favours a mixture of this substance with straw... ». Further down he states : « The manure piles commonly found

near stables where horses are kept furnish suitable breeding conditions. This is especially true in the early spring, when the warmth of the manure appears to be very attractive to the flies for egg-laying ». He also stated : « Experimentally, a few specimens have been reared from pure cow manure, but this substance seems to be unattractive to the adult and not favourable for the breeding of the larvae on account of its very compact texture. The stable fly has never been found breeding in human excrement and does not frequent malodorous places... ».

Surcouf (1921) observed the egg-laying of *Stomoxys* in horse manure. He stated that if fresh horse dung is not present, *Stomoxys* oviposits along the manure heaps in the soil fouled with debris and urine.

Patton (1931) mentioned in page 224 that the female « lays the eggs singly in horse manure, straw soiled with urine, stable bedding, decaying vegetation and household refuse especially tea leaves ».

Seguy (1933) has observed the oviposition of *Stomoxys* in fresh horse, cow and rabbit dung in stables and byres. In rare occasions oviposition takes place out doors on heaps of manure.

Thomsen and Hammer (1936), in their account of the breeding media of some common flies, made extensive observations on Danish farms, and carried out several oviposition experiments in the laboratory to find out the chief breeding media of *Stomoxys*. They stated : « *Stomoxys calcitrans* L. breeds chiefly in the bedding of calf boxes (litter mixed with dung and urine), to a much smaller extent in humid remains of straw, old fodder or other vegetable material left in corners and crevices of stables. *Stomoxys* larvae were only rarely found in horse manure, pig dung and cow dung, Oviposition in the open has not been observed and if existing is quantitatively of no importance ». They also observed from the oviposition experiments that *Stomoxys* preferred egg-laying in horse manure and calf dung.

Observations in the country

The following typical cases may be quoted :

April (1938), Zarka.—A large farm was visited at the beginning of the month. Numerous cows, buffaloes, calves, donkeys and few horses were kept. There was a considerable number of stable flies in the byre (out of a number of 80 individuals examined there were 74 *Stomoxys*). In the horse and donkey stables neither the flies nor their larvae were met with. In a manure heap (mixture of cow, horse and donkey dung) placed near the horse stable about six larvae of *Stomoxys* were found. In the floor of the calf pen there was a thick layer of compact litter and manure which contained a rather large number of *Stomoxys* larvae and pupae. They were found especially along the side walls.

May (1938), Kanatir El Khairieh.—A stable in which a large number of sheep and goats were kept. In a part of the stable three calves and two horses were found in separate enclosures. A few stable flies were met with in the place where sheep and goats were kept, and when their dung was examined it was found to contain no *Stomoxys* larvae. In the calf and horse enclosures there was no adult flies but the larvae were found in small numbers in horse dung and in moderate abundance in calf dung.

Observations in the region of Cairo and some towns

June (1938), Mansourah.—A large stable owned by private people and fitted most exclusively for horse keeping was visited. About 22 horses were found. Their dung is not removed daily and therefore large accumulations of pure horse manure occurred on the floor of the stable. While *Stomoxys* was seen in the stable especially on the walls and ceiling in great abundance, the *Stomoxys* larvae were found in small numbers. But in a near place to the stable a heap of horse dung mixed with straw and urine was found. When this was examined it was found to contain an enormous number of *Stomoxys* larvae.

June (1938), Wailieh.—A more or less primitive farm in a part of which the owner and his family dwells. They lived in two small rooms and were terribly annoyed by the stable fly. Four calves and three cows were kept in a shed close to the farmer's house. Most of the flies examined in the calf pen were found to be *Stomoxys* which seem to migrate to the farmer's house when calves are out at pasture. Near to the barn a heap of humid straw mixed with urine of cattle and some decomposing vegetable matter was examined, and was found to teem with a large number of *Stomoxys* larvae. About a few scores of yards from this farm there was a pig sty containing about 100 pigs. The place was very dirty and the pig dung was found in in large quantities on the floor of the sty. The adult fly was rarely found, but a few larvae were observed in the dung.

September (1938), Demerdash.—A large heap of human excrement left in the open outside the houses was examined. The adult fly was never found on the excrement, and also the larvae were completely absent from it.

Results of observations

Careful investigations in the country have clearly shown that under Egyptian rural conditions the stable fly *Stomoxys calcitrans* L. breeds chiefly in the byres as well as in the calf pens. In these places cows, buffaloes and calves are kept. Some of the dung of these animals is intentionally left by

the farmer on the floors of the byres and pens to afford a soft bedding for the cattle, and usually this bedding is mixed up with straw and food remains and weted with urine. This mixture of dung, straw, urine, etc., was found to be a very favourable breeding medium for *Stomoxys* and the more is the amount of straw and urine the greater is the number of the larvae found. The eggs are deposited singly and usually close to each other, and are forced slightly into the surface of the dung in order to be protected against desiccation. The temperature in these breeding media may be favourable enough to accelerate the period of development. It genrally ranges between 25° C. and 30° C., and sometimes more especially when the quantity of humid straw and litter is greater. In pure cow, buffalo or calf dung the stable flies are usually not attracted for oviposition, and only in a very few cases the larvae were found in pure cow and calf dung in a very small number. Therefore it seems that mixing with humid straw or litter, etc., is a very essential condition for rendering cow, buffalo or calf dung attractive for the egg-laying females of *Stomoxys*. In byres which are carefully looked after and cleaned regularly, oviposition is evidently scanty, but the adult flies may be found in abundance especially when the cows are present and not out at pasture.

The stable fly breeds also extensively in straw stacks, humid remains of litter soiled with urine, etc., and it is unnecessary for these remains to be mixed with dung, but humidity is an indispensable condition for egg-laying and development. Under conditions prevailing in Egypt, especially in towns, there is a rich and constant source of this humid straw which is soaked with urine and slightly mixed with dung. In all the government horse stables a layer of moderate thickness of straw is placed on the cemented floor of the stable where the horses stand. This layer affords a soft bedding for the horses at night, and is naturally wet with urine. Every one or two days this bedding is removed from the stable in carts and left exposed in the open to be utilized as manure. This has been found to be attractive to egg-laying females and considerable numbers of *Stomoxys* larvae are usually met with. The importance of these bedding in the fly breeding can be very easily realised if we know that this breeding substance (humid straw with urine) is furnished daily in very large quantities by the government stables especially those of the army.

In donkey stables the donkey dung mixed with straw and wet urine also affords a favourable breeding medium for *Stomoxys*.

As regards sheep and goat dung it has been found that it is of very little importance as a breeding medium for *Stomoxys*. Only when it is mixed with some decomposing matter or remains of straw it may be slightly attractive for ovipositing flies.

Also repeated investigations have definitely shown that the stable fly

as a rule never breeds in human excrement and usually does not frequent the cesspits, latrines, privy middens or similar places.

In the region of Cairo and several provincial towns it has been found that horse manure mixed with straw and wetted with urine affords suitable breeding medium for *Stomoxys*. The favourable temperature of the dung (about 35 to 38° C.) may contribute to the attraction of the egg-laying females and the acceleration of the developmental period. These conditions are usually furnished in the thick layer of dung and litter which occurs on the floor of horse stables. In large and tightly packed heaps of this manure larvae or eggs are usually not found, that is evidently due to the fact that strong fermentation may take place and the temperature may be sufficiently high to prevent oviposition and development.

But it should be pointed that the part played by this kind of manure in the propagation of *Stomoxys* is decidedly inferior to that played by cow, buffalo and calf dung mixed with straw. In pure horse dung, it seems that oviposition is not common.

As regards pig dung it has been shown that it is not a suitable breeding medium for *Stomoxys* and not attractive for the ovipositing females. The adult flies may be found in the pig sty mainly for biting the pigs. The larvae are rarely found in the dung.

Observations have also shown that *Stomoxys* under the conditions prevailing in this country oviposits in the open as well as in doors in the stables, but more extensively in the latter case.

Oviposition experiments

The above mentioned observations clearly demonstrated that under conditions prevailing in this country the stable fly prefers certain kinds of manure for oviposition. Therefore, as in the case of *Musca vicina* Macq. and the other species of *Musca*, oviposition experiments have been similarly carried out in case of *Stomoxys* in order to test this degree of preference or in other words the power of attraction of the different kinds of breeding media for the ovipositing females.

The experiments have been made in the early summer (April and May, 1938) in the open as well as in doors in the byre and pig sty at Wailieh near Cairo. For each experiment pottery vessels each of about 20 cms. in depth and about 30 cms. in diameter were used. Seven of these vessels were placed in the byre and seven in the open. Seven kinds of dung namely cow dung, buffalo dung, calf dung, horse dung, donkey dung, pig dung and sheep and goat dung were used, and each vessel contained a kind of dung. The dung applied was as far as possible taken fresh from the animals, but it was not sterilized by heating to avoid any possible change in its properties. This

TABLE III

Stomoxys calcitrans L.: Oviposition experiments

DATE OF EXPERIMENT	Vessels exposed in the byre and pig sty							Vessels exposed in the open		
	DONKEY DUNG	SHEEP AND GOAT DUNG	COW DUNG	CALF DUNG	PIG DUNG	BUFFALO DUNG	HORSE DUNG	DONKEY DUNG	SHEEP AND GOAT DUNG	COW DUNG
	Vessel 1	Vessel 2	Vessel 3	Vessel 4	Vessel 5	Vessel 6	Vessel 7	Vessel 8	Vessel 9	Vessel 10
3.4.1938	3	—	31	77	2	15	271	36	6	7
15.4.1938	—	8	15	88	12	35	116	12	—	46
28.4.1938	127	1	32	36	18	—	59	—	11	10
12.5.1938	—	7	26	—	1	18	94	17	—	33
30.5.1938	18	—	6	19	—	1	70	—	5	—

Vessels exposed in the open				Total number of individuals						
CALF DUNG	PIG DUNG	BUFFALO DUNG	HORSE DUNG	DONKEY DUNG	SHEEP AND GOAT DUNG	COW DUNG	CALF DUNG	PIG DUNG	BUFFALO DUNG	HORSE DUNG
Vessel 11	Vessel 12	Vessel 13	Vessel 14							
13	21	2	186	39	6	38	90	23	17	457
92	—	15	98	12	8	61	180	12	50	214
10	7	52	31	127	12	42	46	25	52	90
3	—	21	115	17	7	59	3	1	39	209
44	2	13	68	18	5	6	63	2	14	138

procedure does not guarantee with certainty that the dung utilized might not have contained any eggs at the beginning of the experiment, but there is however no reason to believe that this condition had any considerable influence on the final result of the experiment.

After the vessels had been exposed for egg-laying for about six or sometimes eight hours they were taken to the laboratory where they were covered with special wire netting. When the flies hatched a net was applied to the vessel and the adult flies were obtained, preserved and counted. Generally the results of the individual experiments show agreement with those obtained from direct observation. The experiments have shown that the diferent kinds of dung attract the ovipositing females of *Stomoxys* in varying degrees (see Table III).

Pure horse manure according to experiments had the greatest production of *Stomoxys* as compared with other kinds of dung. Pure cow, buffalo and calf dung attract the ovipositing females to a slight degree. Pig and sheep and goat dung are also little attractive for *Stomoxys*. Donkey dung in one of the experiments yielded a considerable number of *Stomoxys*.

It should be also pointed out that it was noticed from the experiments that the difference in number between the adult emerged from the vessels exposed for egg-laying in door in the byre and those emerged from the vessels exposed in the open is not a considerable one, indicating that oviposition in the open and in the byre may take place nearly in the same proportional degree.

4. The breeding media of Calliphora erythrocephala Meig., Lucilia sericata Meig., and Muscina stabulans Fallen

The review of literature show that the breeding media of these flies have been taken into consideration by some previous workers in different countries. Howard (1900) has recorded *Calliphora erythrocephala* Meig. and *Muscina stabulans* Fallen from human excrement. The latter species was also reared from cow dung. Hewitt (1914) stated that *Calliphora* breeds in faeces and decaying flesh, and *Muscina* in various kinds of decaying fruits, etc.. Portchinsky (1913) has pointed out that *Muscina stabulans* Fallen not only breeds in human excrement and cattle and horse dung but also in meat, carcases of different vertebrates and invertebrates, vegetables, dung, etc.. Patton and Evans (1929) have mentioned that while *Calliphora erythrocephala* Meig. and *Lucilia sericata* Meig. breed in the dead bodies of animals of all kinds, *Muscina stabulans* Fallen breeds in addition, in decaying vegetable matter.

In Egypt, the study of the breeding places of these flies have not been

previously attempted although they are of abundant occurrence especially in the country, and may be important from the practical point of view. Several observations have been made in different localities in the country and in towns in abbatoirs, slaughter houses and wholesale meat merchants, etc.. The results arrived at definitely prove that these flies show a marked preference in ovipositing in carrion, dead bodies of animals, rotten flesh of any kind, etc., and also emphasize the importance of human excrement which seems to be responsible to a great extent for the production and propagation of these flies in Egypt. As it is previously pointed out, human excrement, owing to inadequate sanitary arrangements and the prevalence of the conservancy methods of sewage in the country as well as in some localities of certain towns, occurs in huge accumulations exposed in the open and these afford a very favourable breeding media for these flies especially *Calliphora erythrocephala* Meig. and *Muscina stabulans* Fallen which extensively breed in this substance. Observations have also shown that oviposition is preferred on excrement a few hours after deposition. The temperature inside these accumulations usually ranges between 25 to 35° C. in April and September, which is almost sufficiently favourable to allow oviposition and accelerate the period of development. The other excremental matter such as cattle dung, horse and donkey manure, etc., are generally unfavourable breeding media for these flies except *Muscina stabulans* Fallen which favourably breeds in cow and horse dung. *Lucilia sericata* Meig. and *Calliphora erythrocephala* Meig. rarely oviposits in cattle dung. As regards the decaying animal matter such as the carcases of different animals, etc., it may be said with certainty that these are highly favoured by the flies as breeding media, and that oviposition occurs in these carcases very extensively. Especially in the country the dead bodies of donkeys may be frequently met with outside the villages. These corpses, owing to their large size, usually remain quite a long time before they are completely consumed, and that obviously renders oviposition more extensive and larval development and food conditions more favourable. Carcases of smaller animals such as cats, fowls, rabbits, etc., are undoubtedly less important breeding media since they usually dry up before development is completed. House refuse with decomposing vegetable matter may serve as a breeding substance for *Muscina stabulans* Fallen but, as rule, it plays a very minor role in the propagation of this fly. That is probably attributed to the high temperature in Egypt which contributes to the rapid desiccation of such substances and thus rendering them unfavourable breeding media.

Summary

(1) Under conditions prevailing in Egypt, the horse dung deposited in stables owned by private people as well as that removed from the government stables and exposed in the open afford the chief breeding medium of *Musca vicina* Macq. in towns, whereas in the country donkey dung deposited in stables is the one concerned. Human excrement, owing to inadequate sanitary arrangements and the presence of conservancy methods of sewage disposal in the country, plays a very important part in the production of flies. Sheep and goat dung comes next to human excrement in its practical importance in the fly propagation. Pig dung is of minor importance owing to the limited distribution of this animal in Egypt. It is very striking that *Musca vicina* Macq. never breeds in cow, buffalo or calf dung.

(2) Other species of *Musca*, namely *sorbens* Wied., *vitripennis* Meig., *tempestiva* Fallen, *crassirostris* Stein, *nebulo* Fabr. and *vetustissima* Wlk., mainly breed in cow and buffalo dung deposited in byres under rural conditions in Egypt. Horse manure is a much less favourable breeding medium, but when mixed with cow, buffalo or calf dung it becomes more attractive for ovipositing females of *Musca sorbens* Wied. and *Musca tempestiva* Fallen. Sheep and goat dung and human excrement are also important as breeding media for these flies, but it seems that *Musca sorbens* Wied. and *Musca tempestiva* Fallen highly favour human excrement as a breeding medium. Other kinds of breeding substances such as pig dung, donkey manure, house refuse, etc., do not attract the ovipositing flies.

(3) *Stomoxys calcitrans* L. in the country chiefly breeds in cow, buffalo and calf bedding (humid straw mixed with urine and dung) in byres and calf pens, while near towns it breeds in horse bedding (humid straw mixed with urine) removed from the stables and exposed in the open. Pure cow, buffalo, calf and horse dung is little attractive for the ovipositing females. Donkey dung deposited in stables and mixed with litter may be a favourable breeding medium in the country. Sheep and goat dung, human and pig excrement are as a rule of no importance as breeding media for *Stomoxys*.

(4) *Calliphora erythrocephala* Meig., *Lucilia sericata* Meig. and *muscina stabulans* Fallen are mainly attracted by carrion, dead bodies of animals and rotten flesh of any kind for oviposition and breeding. But these substances do not — as a rule — constitute the principal source of production of these flies owing to their uncommon occurrence. Human excrement, though less attractive yet as a whole, has the greatest production of these flies especially in the country where there is a lack of sanitary arrangements and water carriage systems of sewage, the excrement being left exposed in the open. Other breeding substances, such as house refuse and decaying vegetable matter, may attract *Muscina stabulans* Fallen for oviposition, but generally their importance as breeding media is very little.

IV. MEASURES OF FLY CONTROL

The results arrived at from experiments and observations made with the aim of studying the breeding media of flies have clearly demonstrated and definitely proved that the different flies chiefly breed in definite kinds of dung and other breeding substances which are mainly responsible for the fly propagation. That is very essential in tackling the fly problem since it facilitates its practical control.

The measures of control should concentrate against the early stages of the flies (eggs, larvae and pupae) and not only against the adult. The use of fly straps, insecticides and fumigatiin methods, etc., in byres, stables and living rooms is none the less extremely useful as a measure of secondary importance. The methods of fly control which I have studied will be mainly directed to :

A. The stable refuse.

B. Dung deposited on farms.

C. Accumulations of human excrement exposed in the open.

A. The stable refuse

It is now obvious from studying the breeding places of the house flies that stables constitute one of the principal sources of fly production under conditions prevailing in Egypt. The horse stables will be first taken into consideration, the others, including cattle sheds, calf pens, donkey stables, etc., will be discussed later.

A large number of horse stables is owned by private people. The stables are not cleaned except at long intervals of weeks or even of months and thus accumulations of horse dung occur on the floor of the stable. Some of this dung take part in the formation of the bedding of the horses, the other which is the major quantity is left exposed in the open for several days to ferment. The surface temperature which is about 35°C. in the early summer in such exposed heaps is usually sufficiently favourable to attract the ovipositing females. That was evidently proved by observing a large number of batches of eggs on the surface. In the centre of the heap the fermentation temperature may be high enough to kill the larvae, but these usually migrate to the surface and lateral regions where lower temperature is available. These heaps of horse dung are indeed, under conditions prevailing in this country, a considerable source of fly propagation. The developmental period of flies is accelerated by the favourable food and temperature conditions. After testing several methods for their efficiency in the prevention of fly breeding in horse manure, my observations and experiments definitely prove that the biothermic method together with some supplementary measures are the most useful in this respect and give the best results.

Thomsen (1934) has pointed out that covering the horse or pig manure with cow dung seems to be an efficient method of reducing the number of flies on Danish farms. This is based on the fact that in Denmark — and probably in some other countries — cow dung generally does not attract the house flies for oviposition. But since cow dung in Egypt affords the most suitable breeding medium for several species of *Musca*, it will be obvious that such method advocated by Thomsen cannot be applicable here, and even if this drawback is surmountable I am inclined to believe, supported by observations, that the efficacy of Thomsen's covering method with cow dung is doubtful since cow dung when mixed with horse or pig dung becomes attractive to the egg-laying females, and in addition if the manure underneath consists of fermenting horse dung, the steam given off may be sufficiently strong to permeate through the covering of cow dung on the surface and thus house flies are attracted for oviposition on cow dung. That was proved by observations on some farms, and is in agreement with Roubaud (1936). Also covering the manure heaps with sacks, tarpaulins, as suggested by Thomsen (1934), would be perfectly successful if the steam given off during fermentation is not of a high temperature which may cause the rapid deterioration of the cover, and consequently flies may lay large quantities of eggs on the parts of the cover which have become worn or thin and therefore it is uncertain whether this method can be advocated for general use under rural conditions (Roubaud, 1936).

The spreading of manure in a thin layer of about 5 cms. in thickness has been tested and tried several times as a measure of preventing the fly breeding and in all cases very satisfactory results have been obtained. In spring, summer and autumn such layer of manure spread on the ground in the sun requires two days or less to become completely dry owing to the high temperature — which may reach 50° C. or more — in Egypt in these seasons. In winter the time may be prolonged to about four days or more, but in either cases any eggs or larvae that may be present in this layer of dung will in all probabilities fail to complete development and will perish through lack of food and unfavourable conditions of humidity. This method was tested by Lorincz and Makara (1935) in Hungary. The method has some disadvantages, it requires a considerable amount of labour and a prolonged supervision in order to obtain good results. Moreover an extensive area is necessary for the spreading of the manure especially when the latter is in enormous quantities. Some of the larvae may also bore downwards and reach the surface of the soil beneath and may succeed to pupate. That was proved to be the case in several occasions especially on the advent of winter, when pupae were collected in considerable numbers about three inches deep in the soil just below the dung. The wind may also carry particles of the

dung anywhere. Furthermore, when this method was suggested to farmers, gardeners, etc., it was instantly rejected as laborious and needing a considerable effort.

The use of chemical insecticides as a principal method for combating the fly breeding in horse dung was also tried. Spraying manure heaps with fly deterrent solutions has often been favoured, apparently owing to the fact that the flies are not attracted to manure after being sprayed, and that any larvae present will be killed. But in order to prove that this is not always the case, especially in large manure heaps, a simple turning over of the surface of the manure clearly shows that the fly larvae can be found beneath, the solution sprayed on the surface having failed to check the hatching and subsequent development of larvae from the eggs previously laid on the fresh manure. It has been also found that treating the manure with insecticides generally inhibits or retards the process of fermentation. Solutions of kerosene, phenol have been tested and proved useful with small heaps of manure, but in large heaps they serve as a supplementary measure only owing to the fact that they evaporate rapidly, especially in hot weather, and their effect becomes very evanescent and flies have been observed to lay eggs on manure shortly after spraying. Also numerous larvae have been found to escape the destructive action of these insecticides. The resistence of larvae to the action of chemicals is very pronounced but there are certain larvicides which give very satisfactory results such as borax or hellebore. But it should be pointed out that although the application of chemicals to manure heaps may give good results in the hands of capable and conscientious people yet it cannot be advocated in a general way as a principal measure of control, and moreover it is practicable only in cases where expense is of no consideration.

As recommended by Madsen Mygdall the hot water of about 70 to 90° C. was used for killing the fly larvae in horse manure, but it has been found after several trials that this method does not always give good results especially where the daily quantity of manure is comparatively large, but as a supplementary measure it is undoubtedly useful.

After testing the efficacy of all the methods mentioned above in the prevention of fly breeding in horse manure, the present author has come to the conclusion that the most efficient method is the biothermic method applied together with one or more of the supplementary measures.

The underlying principle of this method is the destruction of the house fly in its early stages, mainly the larval stage, by means of a process involving the tight and close packing combined with frequent turning over the upper layers and subsequent storage for fermentation, entirely carried out in a suitable receptacle so constructed as to form a larval trap.

The pressing down of the manure which is frequently watered results

into the generation of a high temperature owing to the process of fermentation. The temperature, especially in the centre of the fermenting manure, may be as high as 90° C. which is of a very detrimental effect and absolutely fatal to flies at all stages of development. It was found, however, that numerous larvae escape from the hot middle regions and migrate to the surface and lateral regions of the heap where temperature is lower, and thus many of them may succeed to complete development and pupate. Therefore, precautions were taken and their migration was prevented by the presence of an open channel in which they are entrapped and killed in borax solution. Moreover, the escape of the larvae over the walls is checked by the projecting and overhanging ledge which cause them to fall back on the heap. In order to prevent the larvae from reaching the soil beneath the packed heap, the

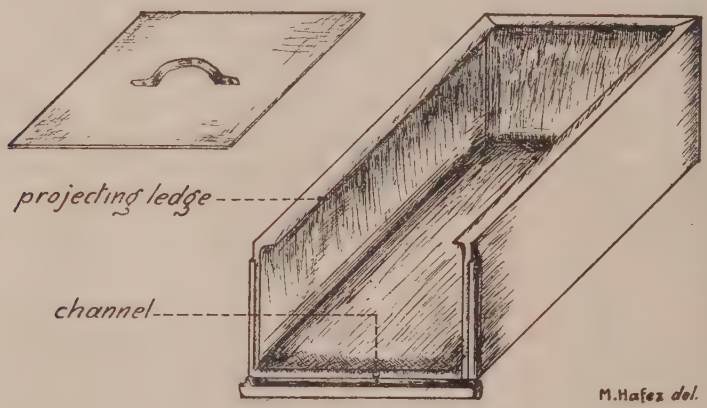

Fig. 1. — Storage chamber.

floor of the receptacle must be completely impervious. The outer exposed layers of the manure heap must be raked off and turned into the hot centre every day during the process of close packing in order to kill any larvae that have migrated to the surface. When the rammed manure heap attains a convenient size, it is left to ferment and frequently watered to promote the process of fermentation for killing the surviving larvae and rendering the manure unattractive for ovipositing flies.

Based on these facts and bearing in mind the necessary precautions, two manure receptacles or chambers have been constructed for alternative use. They proved very satisfactory and excellent results have been obtained. With minor modifications they may be adaptable to any local conditions, for they are not expensive and again the method can be very easily carried out at rural or urban conditions. The chamber (Fig. 1) is a wooden box

(1.50 × 1.00 × 0.50 metres) lined internally with zinc. The box is three-sided — the roof being removed and there is an open gutter in front. To this open front a sliding wooden shutter is fitted in a special groove, and it serves only to protect the open gutter from falling manure and is not intended to help close packing by any means since it is not suited for this purpose either structurally or from its position. When the shutter is fitted, care must be taken in order to prevent it from closing completely down. This provision allows the migrating larvae to pass beneath the shutter to be trapped in an open channel beyond. The floor of the chamber leads in front into an open channel made of zinc running close to the front edge and slightly sloping and closed from either sides by means of stoppers. The channel is filled with a solution of borax prepared by dissolving one sixth of a pound in a gallon of water. The upper edges of the lining zinc are made in such a way that they project inwards and provide an overhanging sharp edge.

TABLE IV

Temperature generated
in fermenting horse manure heap

DATE	TEMPERATURE IN °C. AT 11 A.M.	TEMPERATURE IN °C. AT 3 P.M.
3.9.1939	68	66
4.9.1939	72	75
5.9.1939	83	79
6.9.1939	80	81
7.9.1939	82	82

Into one of the two chambers the horse dung from the stable is stocked daily and then pressed down tightly. Every day's dung is accumulated on the previous day's supply and rammed closely against the floor and the side walls. The liquid manure is drained off from the open channel in which the borax solution is placed immediately after. The base of the stacked manure in the chamber must be away from the open channel in front by at least ten inches. After few days, the stacked manure heap becomes sufficiently large to fill the chamber, but it should be borne in mind that the surface of the heap must be away from the inwardly projecting edges of about six inches. The chamber being now filled, the shutter is fitted and then left for a few days in order that the manure contained completes the process of fermentation. Every morning the turning over of the surface layers and the addition of some water are necessary. During this time, the other chamber may be

used, and when filled the first chamber is emptied and used and so on alternatively. During the process of fermentation a high temperature is engendered. Measurements of temperatures were taken twice or more every day by placing the thermometer in the centre of the fermenting manure heap. The temperature recorded (see Table IV) is sufficiently high to destroy all the early stages of flies. In several cases the temperature may reach a maximum far in excess of the temperature necessary to kill the larvae. The highest temperature recorded was 92° C. In order to investigate the larvicidal action of temperature generated in the manure heap a series of experiments have been conducted. The conclusion arrived at clearly demonstrates that the stage of development of the larvae in an important factor in determ-

TABLE V

Period of exposure *in seconds* which proved to be fatal to larvae of *Musca vicina* Macq.

TEMPERATURE IN °C. TO WHICH EXPOSED	FIRST STAGE LARVAE	SECOND STAGE LARVAE	THIRD STAGE LARVAE	FULLY MATURE LARVAE
45	280	320	480	600
46	197	210	294	360
48	106	170	221	300
49	99	130	197	281
50	73	96	112	198
51-52	46	75	91	179
52-53	37	56	71	153
54	23	40	52	121
55	10	22	35	100

ining the lethal degree of temperature and the time of exposure required (see Table V). First stage larvae of *Musca vicina* Macq. are generally killed in about 10 seconds at a temperature of 55° C., the second stage larvae in about 22 seconds, the third stage larvae in about 35 and the fully mature larvae in about 100 seconds at the same degree of temperature. These measurements have been obtained in « wet » heat i.e., the larvae were submerged in water.

Owing to the high temperature in the centre of the fermenting manure, the larvae have been observed to escape to the upper and lateral regions where temperature is favourable and much lower than that of the centre. That was evidently demonstrated by the presence of very considerable numbers of larvae in the surface layers and on the side walls, trying to climb in vain the in-

wardly projecting ledge and finally tumbling onto the heap again, some falling on the floor of the chamber where they are entrapped in the channel and destroyed in the borax solution. Therefore, it has been found essential to turn over the upper layers of the heap daily and bury them into the hot middle region, and thus the larvae are destroyed, those of the first and second stages are instantaneously killed. It has also been observed that although the upper surface of the manure heaps is left exposed, yet no oviposition takes place, being evidently due to the fact that during the process of turning over the fermented manure is brought to the surface, such manure having lost its power of attraction for the ovipositing flies which show a marked repugnance to fermenting manure.

In the course of a few days (about 7 in my case), the process of fermentation is completed, the manure acquiring then a blackish colour and fine texture. The manure is now taken out from the chamber and can be utilized as a land fertilizer. In order to ascertain how flies behave towards this manure after this process, it was exposed in the open and was kept under observation. In nearly all cases no flies were seen on the manure and egg-laying never occurred.

The question naturally arises as to the extent to which the agricultural value of the manure is affected as to the result of the high temperature generated when the manure heaps are closely packed in the manner advocated for the prevention of fly breeding. Parisot and Fernier (1934) in France have pointed out that the high fermentation temperature has no unfavourable influence on the chemical composition and hence on the agricultural value of the manure. Analysis had shown that the manure after the process of close packing and fermentation, is richer in its manurial properties when compared with other manure not treated in the same way. Nitrogen content has been found to be distinctly higher. Similar results have been obtained here by the present author.

It may be here pointed out that the size of the chamber previously described may be subject to variation according to the quantity deposited in different stables. The cost price of the two chambers, although not expensive at all, still may not be within the financial reach of some stable owners, and therefore a simpler though less efficient method may be advotaced for use to keep down the number of flies to a tolerable minimum. A wooden box of about a quarter of a cubic meter (1.00 × 0.50 × 0.50) in size was used. At the floor of this box three or four rounded holes each about 10 cms. in diameter are made and then covered with fine wire gauze. In one of the corners of the stable every day's supply of dung is accumulated in a cone-shaped heap to afford fermentation. On the fourth or fifth day the manure heap is transferred to the wooden box and pressed down against the floor

and sides of the box. During the process of close packing, the liquid manure is drained off through the holes in the floor of the box. The box is then closed and the manure is left to complete fermentation. Every morning the upper layers are turned over and buried in the hot middle regions of the manure to kill any larvae present on the surface. Frequent watering is necessary to promote fermentation. In about five days the process of fermentation is completed, most of the larvae are killed, and then the box is emptied and used again and so on.

The other sorts of stables such as those for cows, buffaloes, calves, sheep, donkeys, etc., play an important part as breeding places for flies. These stables are widely distributed in Egypt, and in most of the cities, provincial towns and all villages they are of common occurrence. It usually happens especially in the country that the cattle sheds, calf pens, donkey stables, etc., are associated with the farmer's house. As previously mentioned, the floor of the stables is usually provided with a thick layer of litter mixed with dung and urine which serves as a bedding for animals. This bedding attracts the ovipositing flies in large number and is a favourable breeding medium for flies. Therefore, the first step which must be taken in order to keep down the number of flies is to change this bedding — which may be preferably formed of straw — every two or three days, and to expose it in the sun to dry so that any eggs or young larvae that may be present will undoubtedly perish from lack of food and unfavourable conditions of humidity.

As to the dung deposited on the floor of the stable, it may be collected and accumulated outside the stable. This dung must not be left a long time but dealt with a shortly as possible to avoid any development of flies. The dung is better made into « dung discs » which will be utilized as fuel after drying them in the sun. Farmers are used to this practice and it is a prevailing habit among them. The common practice of making dung into discs and its importance in the prevention of fly breeding will be discussed later in detail.

B. Dung deposited on farms

Cow and buffalo dung constitute by far the greater part of dung deposited on farms in Egypt. In nearly all the small farms and some of the large ones the practice of making dung into discs — which will be utilized as fuel after drying them — is very common among farmers. The dung is collected and mixed with water, and then made into flat discs each of about 3 cms. in thickness and 40 cms. in diameter. These « dung discs » are then exposed in the sun to dry. The disc takes about two or three days in spring, summer or autumn and about four or five days in winter to become completely dry and ready for use as fuel. This practice is prevalent in Egypt since these

dried discs of dung constitute one of the main sources of fuel in the country. A thorough investigation has been made in the early summers of 1938 and 1939 in order to ascertain any practical importance of this practice of making dung into discs as far as fly control is concerned. Therefore, numerous farms were visited and inquiries made as to the cattle dung. It was found that out of 140 farms visited, there are 128 farms in which the dung is made into discs, while in the remaining farms the dung was stored to be utilized as manure. A large number of newly made « dung discs » were examined every day. In most cases the third stage larvae of flies were found in large numbers, tending to bore downwards in the substance of the disc while some of them were found on the surface of the soil just below the disc. Numerous pupae were also found about one centimetre deep in the soil. In very few cases batches of eggs and first or second stage larvae were met with in the dung of the disc. These discs were kept under observation until they became completely dry. It was found that most of the third stage larvae succeeded to complete development and pupate while the younger larvae or eggs perished. As the discs usually dry up in about two or three days — that is to say long before the life cycle of flies is completed — it is obvious that any eggs or young larvae that may be present in the dung of these discs will undoubtedly fail to develop, and will ultimately die through lack of food supply and unsuitable conditions of humidity. But, as the third stage larvae pupate nearly at the time by which the disc is about to become dry, it is obvious that in this case the life cycle of the fly is completed and the adult emerges. Unfortunately, this latter case is the one that prevails owing to the fact that the farmers accumulate the dung and allow it to remain about three or more days until it becomes of a moderate size and then made into discs. It is evident that during these three days in which the dung is accumulated in the open, the females are attracted in large numbers for laying eggs which subsequently hatch and reach the third larval instar in the course of about two days. Thus, when the dung is made into discs, it contains a large number of third stage larvae. In a few cases, the dung accumulated on farms was dealt with and made into discs few hours after deposition, and thus the dung was not exposed long enough for oviposition.

Bearing in mind the results obtained from these observations on farms, it has been found that an essential condition must be fulfilled in order to make the common practice of making dung into discs for fuel efficacious in the prevention of fly breeding. This condition is to deal with the dung as freshly as possible. One day (24 hours) must be regarded as a maximum duration in which the dung may be left on farms before making it into discs. In several farms where the practice of making dung into discs was performed by farmers as suggested, the number of flies was remarkably kept down to a tolerable minimum in about one month time.

In most of the large farms in Egypt, the dung is not made into discs but stored to be utilized as manure. The dung is usually collected and accumulated in heaps or rectangular blocks (Fig. 2) which may reach 20 meters long, 10 meters broad and 2 meters high. There may be two or three of such enormous stacks in one farm. The dung, after several months, is utilized as a land fertilizer. As such heaps or stacks are left exposed and furnished daily with fresh dung deposited on the surface, they become very attractive for the egg-laying females and afford a suitable breeding media for flies as well.

Fig. 2. — A heap of cow and buffalo dung mixed with horse manure.

In order to deal with such heaps of dung, several attempts were made using the biothermic method but the results obtained were very unsatisfactory and the method proved very unsuccessful in this case. It was attributed to the fact that the temperature generated in heaps of cow or buffalo dung during the process of fermentation is not sufficiently high to kill the eggs, larvae or pupae. Several measurements were taken and the maximum temperature recorded was about 30° C. Such temperature is undoubtedly not fatal but, on the contrary, favourable for development. In some farms the dung heaps may consist of an admixture of cow and buffalo dung to other kinds of manure such as that of horse, donkey, etc. This will also tend to lower the general temperature and thus make Roubaud's biothermic method impossible. Means of increasing the heat of the fermentation such as close packing were tried but also proved impracticable owing to the high water content and fine texture of the dung.

The best method which may be advocated for use on the large farms in

Egypt and which gives very satisfactory results in the prevention of fly breeding as proved by my observations and experiments may be described as follows:

The dung is collected and accumulated on the farm (it is better to avoid the enormous increase in size of the dung heap by making smaller heaps in order to facilitate the measures to be carried out). Then a solution of borax (1.5 ounces of borax dissolved in 2.5 gallons of water) is sprinkled over the surface of the heap in ordrer to kill any fly larvae present in the dung. Borax is very cheap and easily obtainable and it does not affect the manurial properties of the dung so long it is used in moderate quantities. But as there is always a daily supply of fresh dung thrown on the surface of the heap, then there is also a continuous source of attraction for the ovipositing females since these are only attracted by the fresh dung. Flies show a marked repugnance to even one day old cow dung. If advantage is taken of this peculiarity of flies and if instead of throwing the fresh dung on the surface of the manure heap it is buried in its inner layers in the centre, oviposition will be considerably reduced as the surface layer will be mainly constituted of old dung and provided with a hard thin crust. In addition to this precaution of burying the fresh dung inside the manure heap, covering with a thick layer of dry soil spread all over the exposed surface of the manure heap is of great use in preventing the flies from oviposition or even from gaining access to the manure heap.

This procedure, if carefully followed and conscientiously undertaken, gives very satisfactory results, and moreover it is simple, easy to carry out, and nearly costless.

C. Accumulations of human excrement exposed in the open

It has been previously pointed out that the lack of the water carriage system in the country and several districts of some provincial towns, and the presence of the conservancy methods of sewage such as privy middens, cesspits, latrines, etc., constitute the greatest menace to the public health and have rendered human excrement very important from the practical point of view. In several villages there are no water closets of any sort in the houses. The faeces are accumulated in the open in heaps which gradually grow by daily additions of fresh excrement, and besides their danger as a source of infection, they are a favourite breeding medium for flies.

The treatment of human excrement with an insecticidal substance was adopted with a view of destroying any larvae living inside as well as preventing any flies from oviposition on the surface. Several chemical compounds have been tested for their larvicidal power. Chloride of lime (bleaching powder), kerosene, phenol, iron sulphate solution, borax (sodium borate in

the crude form) were all tested. It has been found that some of these compounds, namely kerosene and phenol, are unsuccessful when applied on a large scale, for a considerable proportion of larvae escaped injury. Even had all the larvae been killed the cost of the treatment would be prohibitive. Chloride of lime usually yields very good results and in one of the experiments in which this insecticide was scattered on the excrement a greatest mortality was recorded and the smell of the chlorine given off by the lime prevented the flies from gaining access to the excrement for oviposition. But the most efficient insecticide which may be strongly recommended for its marked larvicidal power as well as to its cheap price is borax. About one eighth of a pound dissolved in one gallon of water and sprinkled all over the exposed surface of the human excrement gave the best results in my experiments. After treating the excrement with borax solution, it is preferable to cover the surface with a thick layer of earth which mostly prevents the smell of the excrement from exercising its influence in the attraction of ovipositing flies. But it should be emphasized that, in order that the application of the chemical method yields the most satisfactory results and is carried out with a marked success, it should be in the hands of capable and conscientious people and not left for the farmers or villagers to undertake. Therefore, the authorities with their organized efforts can take up this work.

Other measures

It is now obvious that the different measures of fly control which I have applied were mainly directed to the stable refuse, dung deposited on farms and to the accumulations of human excrement as these constitute the most important breeding places of flies under natural conditions prevailing in Egypt. But it should be borne in mind that in order to obtain the best possible results in the suppression of flies and keep down their numbers to a minimum, the other breeding media such as domestic organic refuse accumulated in dumps, contents of cesspits, faeces promiscuously deposited in open yards, masses of fowl dung in the farmer's house, dead bodies of animals, etc., have to be taken into consideration. The best applicable measures as far as these breeding media are concerned are the preventive measures. The prompt destruction of garbage heaps and house refuse by means of an incinerator is the most preferable measure which will prevent their being a public nuisance and a serious breeding media for flies. The disposal of the contents of cesspits must be carefully undertaken. The dumping place should be outside the town or village about one kilometer distant, and should not be windward. Sewage should be at once covered by a good thickness of dry soil. The regular cleaning, the removal of faeces promiscuously deposited on roads, yards, etc., the removal of the dung of fowls and

other birds usually accumulated in the country houses, and the immediate burial of dead animals are necessary requirements for combating the flies and must form with the other measures an integral part of any sanitary system.

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Notes sur quelques *Cerceris* de la faune égyptienne

[Hymenoptera : Sphegidae]

par le Dr. A. Honoré

Le Dr. A. Mochi a publié en 1939, dans le Bulletin de la Société Fouad Ier d'Entomologie [volume XXII, 1938, pages 136-229], sous le titre « Revisione delle Specie egiziane del Genere *Cerceris* Latr. », une étude certainement intéressante en elle-même, mais restant bien loin en-deçà du but que l'auteur a dû se proposer.

Evidemment, les descriptions in-extenso des espèces sont très complètes, les planches noires et en couleurs, exécutées d'après les dessins originaux de l'auteur, sont remarquables ; mais tout cela n'est pas une « Révision » des espèces égyptiennes du genre, c'est une étude détaillée des espèces anciennes et nouvelles connues de l'auteur. Celui-ci semble faire preuve d'une indifférence presque complète vis-à-vis des travaux de ses devanciers, négligeant les synonymes acquis ou à établir, passant même sous silence des espèces qui doivent bien se retrouver un jour, comme par exemple *Cerceris Schmiedeknechti* décrit par F. F. Kohl en 1898, sur des insectes recueillis par le Dr. Schmiedeknecht à Hélouan!

Voici, dans l'ordre chronologique, la liste des espèces décrites ou citées d'Egypte et de la région Sinaïtique, ainsi que les synonymes connus ou établis, sans tenir compte des espèces nouvelles du Dr. Mochi.

Spinola (1838) décrit *rutila* ♀, dont *rubecula* Schlett. ♀ est un synonyme ; le mâle de *rutila* a été décrit par Klug sous le nom de *excellens*. Spinola décrit encore *tricolorata*, *Fischeri*, *Waltli*, *chlorotica* et *flaviventris*. Ce dernier nom étant preoccupé (Van der Linden, 1829), Klug le changea en celui de *Spinolica*. Les trois dernières espèces doivent tomber dans l'oubli, faute de pouvoir être identifiées avec certitude.

Dahlbom (1843-1845) décrit *erythrocephala* ♀, dont *nasuta* ♀ Lep. (1845) est un synonyme probable. *Erythrocephala* ♀ Schlett. (1887) est une tout autre espèce. Le mâle certain de *erythrocephala* Dlb. a été décrit par

Kohl qui considère *selifera* Schlett. (1887) comme un synonyme très probable.

Les trois autres espèces de Dahlbom, *histrio*, *dispar* et *solitaria*, sont vouées à disparaître de la nomenclature.

Klug (1845) décrit *pulchella*, *histrionica*, *vidua* ♂, *insignis* ♀ et *annulata* ♀ ; Schletterer (1887) redécrit *annulata* ♂ et ♀ en changeant le nom en celui de *Klugi*, l'autre étant préoccupé par Rossi (1794). Il y a encore *albicincta* ♀ Klug, dont le mâle sera décrit par Schletterer.

Lepeletier (1845) décrit *capito* ; il cite *fasciata* Spin. (probablement synonyme de *arenaria* L. et qui n'a d'ailleurs pas été retrouvé).

Walker (1871) décrit *contigua* ♂♀ et *alboatra* ♂, dont la femelle sera décrite par Mochi.

Taschenberg (1875) décrit *lutea* ♀, dont le ♂ sera décrit par Schletterer.

Morawitz (1883) décrit *orientalis* ♀, déjà employé par Smith (1856) et changé en *eugenia* par Schletterer.

Radoszkowski (1886) décrit *Komarowi* ♀ (qui sera retrouvé en Egypte). Morice (1897) décrit le mâle de *Komarowi* sous le nom de *hirtiventris*. Ce n'est qu'en 1911 qu'il décrit le mâle sous son véritable nom, mais sans en reconnaître la synonymie.

Schletterer (1887), indépendemment des changements de noms indiqués ci-dessus, décrit *subimpressa* ♂♀, *chromatica* ♀, *nilotica* ♂ (= *lutea* Tasch.).

Morice (1897) décrit *pallidula* et *pruinosa*.

Kohl (1898) décrit *pharaonum* et *Schmiedeknechti*.

Nous avons ainsi au total une quarantaine de noms spécifiques, dont : 20 espèces valables et certaines pour la faune ; 5 espèces signalées, suffisamment bien décrites pour pouvoir être identifiées par la suite ; 8 synonymes établis ; 7-8 espèces qui, en l'absence des types, devront bien disparaître, faute d'une description suffisante.

Le Dr. Mochi, dans sa « Revisione », cite et décrit 18 espèces, dont : 13 espèces déjà décrites sur un des sexes au moins, et dont 2 signalées pour la première fois en Egypte (*Komarowi* et *Döderleini*) ; 5 espèces nouvelles (*sulcipyga*, *Priesneri*, *Alfierii*, *lateriproducta*, *Honorei*), plus 3 variétés nouvelles.

2 espèces sont vaguement citées (*emarginata* Panz. et *lunata* Costa) et 4 espèces sont définitivement abandonnées.

Faisant abstraction des espèces nouvelles décrites, et des espèces citées pour la première fois, le Dr. Mochi retient ou fait mention de moins de 20 noms, moins de la moitié des noms connus avant la publication de sa « Revisione » !

Il n'entre pas dans mes intentions de refaire ab ovo le travail du Dr. Mochi, mais simplement de relever les omissions et les erreurs d'interprétation de l'auteur. J'en commettrai peut-être moi-même; j'espère que l'on voudra bien ne pas m'en tenir rigueur : il n'est pas de censeur infaillible.

Pour éviter toute amphibogie, je dois préciser le sens de certains termes.

Le pronotum n'est visible en dessus que par sa tranche postérieure appliquée au bord antérieur du mésonotum. Beaucoup d'auteurs emploient un terme abbréviatif, inexact mais commode, *collare*. On pourrait dire en français *collier* ou *collet;* je préfère encore dire *bord postérieur du pronotum* ou *pronotum* tout court.

Segment médiaire: Cette vieille dénomination due à Latreille a le grand mérite de correspondre aux apparences et d'être exacte en fait. Par contre, le terme métathorax à proprement parler est inexact. Le segment médiaire est formé par la soudure intime d'une partie du métathorax avec le premier segment (embryologique) de l'abdomen ; il comprend tout ce qui est postérieur au postscutellum jusqu'à l'articulation avec l'abdomen.

L'*aire cordiforme*, espace généralement bien délimité occupant le centre de la partie supérieure du segment médiaire, affecte, dans le genre *Cerceris*, sauf de rarissimes exceptions, une forme triangulaire dont la base est appliquée au postscutellum. Il serait plus simple de l'appeler « aire triangulaire », et certains font ainsi, mais l'usage de l'appeler « aire cordiforme » s'étant maintenu, continuons aussi.

Le premier segment visible de l'abdomen, plus ou moins rétréci par rapport au suivant, porte le nom de *pétiole*. D'après les données embryologiques, il serait le deuxième segment abdominal, le premier étant soudé avec les pièces formant le segment médiaire. Mais ceci ne cadre pas avec la morphologie extérieure actuelle, sur laquelle est basée la systématique. Je sais bien que certains trouveront à y redire, mais je ne puis me résoudre à appeler deuxième segment ce qui est en fait le premier visible.

Je terminerais ce préambule par un conseil d'ordre pratique.

Le flacon au cyanure est un mauvais procédé de chasse pour les hyménoptères à bandes ou taches jaunes ou blanches : ces couleurs virent au rouge sous l'influence des vapeurs de cyanure. On a beaucoup prôné, dans ces trente dernières années, pour remplacer le cyanure, l'éther acétique ou acétate d'éthyle, qui modifie moins les couleurs, et a de plus l'avantage de ne pas raidir les articulations. Néanmoins, ce procédé présente malgré tout un inconvénient sérieux : les blancs d'ivoire et les blancs jaunâtres de certaines espèces tournent au jaune franc si le contact des insectes avec les vapeurs d'éther acétique se prolonge un peu trop, une matinée de chasse par exemple ; ainsi pour *lateriproducta* qui est d'un blanc d'ivoire et rouge clair sur fond noir, et non jaune, comme le dit Mochi; ainsi encore, le cinquième segment

abdominal chez *Fischeri* femelle n'est pas jaune comme les précédents mais d'un blanc éclatant qui fait reconnaître l'espèce à première vue. J'ajouterais incidemment que pour les Hyménoptères très poilus, comme les Apides, l'éther acétique ne vaut rien.

Le seul procédé de chasse qui m'ait donné satisfaction est l'éther sulfurique (ou éther ordinaire) très pur, déjà recommandé depuis bien longtemps par Friese et Schmiedeknecht, adopté par Morice, Kohl et bien d'autres.

Il est volatil, c'est entendu ; il faut recharger de temps en temps le flacon de chasse, ou mieux encore, en avoir de réserve, donner le « coup de grâce » à la fin de la chasse, mais les résultats comme tenue des couleurs et facilité de préparation sont inégalables.

Je voudrais bien ajouter à la Bibliographie donnée par le Dr. Mochi les ouvrages suivants :

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Lucas (1849) : Exploration scientf. de l'Algérie, tome III et Atlas.
Walker (1871) : Hymenoptera of Egypt collected by Lord.
Taschenberg (1875) : Zeitschr. f. d. Gesamm. Naturwissensch.
Morawitz (1883) : Mag. Akad. Term. Ertek, Vol. XIII.
Radoszkowski (1886) : Horae Soc. Ent. Rossicae.

Cerceris erythrocephala Dahlb., 1845 (non Schletterer, 1887).

Schletterer a déjà corrigé lui-même son erreur dans le « Supplément à sa Monographie » en 1889. Morice relève aussi l'erreur, mais il en commet une autre en considérant cette espèce comme une variété de *tuberculata* Vill. Il a eu en main, sans le décrire, le mâle de coloration normale, et aussi un mâle de coloration semblable à celle de la femelle. Kohl a repris la question dans son « Mémoire sur l'Expédition à Socotra », en 1907, où il décrit le mâle certain en se basant sur des exemplaires capturés en Egypte en même temps que la femelle ; *selifera* Schlett. est un synonyme presque certain.

Des formes de passage existant entre le mâle jaune et le mâle noir, il n'y avait guère d'utilité à affubler cette variation du nom de *gynochroma* ; pourquoi ne pas se contenter de *aberratio feminae colore* ?

Cette même espèce avait encore été décrite, en 1845 également, par Lepeletier sous le nom de *nasuta* ♀ et Lucas en a donné une figure coloriée dans son « Atlas de l'Exploration de l'Algérie ». Une question de priorité assez épineuse aurait pu surgir, mais par bonheur *nasuta* a déjà été employé par Latreille en 1809, pour *labiata* Fab.

Ne pas confondre avec *nasuta* Dahlb. (= *quinquefasciata* Rossi).

Espèce xérophile. Je ne l'ai pas trouvée dans les zones cultivées.

Cerceris capito Lep.

Contrairement à l'espèce précédente, j'ai pris celle-ci très communément dans les zones de culture (Hawamdieh, Tarfaia, Mazghouna, etc.), principalement sur les inflorescences de poireaux et d'oignons.

Cerceris rutila Spin., 1838 (*rubecula* Schlett., 1889, non *rubecola* comme l'écrit Mochi ; ♂ = *excellens* Klug.

J'ai pris quelques exemplaires des deux sexes en Février, à Hawamdieh, les femelles sur le réséda cultivé, les mâles volant sur les plantes basses, sans marquer de préférence.

L'insecte qui a servi de type pour la description du mâle (Dr. Mochi) n'a pas d'autre origine. Ce sexe n'était pas véritablement inédit : il y avait longtemps que je le possédais dans ma collection sous le nom de *excellens* Klug ; les termes de la description de Klug s'adaptent parfaitement aux individus en question. N'ayant pas pris les deux sexes ensemble, j'avais toujours hésité quelque peu à les réunir, tout en considérant leur parenté comme très probable.

Le dessin du clypeus de la femelle donné par le Dr. Mochi (figure 4 de la planche VI), vu de face, n'est pas exact : la partie médiane surélevée n'est pas aussi détachée que l'indique la figure, et les côtés de la plaque forment un angle plus ouvert et à bord droits.

Cerceris Komarowi Radoszk., 1886 ♀ (♂ exclus?) ; ♂ Morice, 1911 (*hirtiventris* Morice, 1897).

Le Dr. Mochi l'a indiqué comme trouvé par moi à Sakkarah et à la bordure du désert ; en réalité les nombreux spécimens que j'ai capturés proviennent de Hawamdieh. Les femelles ont un vol puissant et soutenu, très caractéristique, ressemblant beaucoup à celui des grands odonates inspectant au vol leur terrain de chasse.

Cerceris lutea Taschenb., 1875 (♀ seulement).

Le mâle décrit par Taschenberg et repris par la suite par André, n'est certainement pas le vrai mâle décrit par Schletterer sous le nom de *nilotica*. Assez répandu aux environs du Caire, les mâles étant beaucoup plus fréquents que les femelles.

Cerceris pruinosa Morice, 1897 (*pallidula* Morice, 1897, et *pulchella* Klug, 1845).

C'est très probablement dans ce petit groupe que devraient se loger les trois espèces jaunes de Spinola : *chlorotica*, *Waltli* et *flaviventris* (*Spinolica*), que nous pouvons considérer comme perdues faute des types. *Flaviventris* pourrait bien être *pallidula*, et *chlorotica* serait la *pulchella* ?

Cerceris alboatra Walker, 1871 et **Cerceris vidua Klug, 1845.**

Le Dr. Mochi décrit la femelle « inedita » de *Cerceris alboatra*, ou du moins ce qu'il considère comme telle, car l'auteur ne disposant que d'un seul exemplaire, émet quelques doutes sur la légitimité de la réunion des deux sexes.

En fait, l'attribution est exacte. J'ai pris assez communément les deux sexes ensemble, à Hawamdieh, de Mai en Juillet, sur les inflorescences de poireaux et d'oignons. Dès 1924, j'avais capturé isolément les premières femelles que je considérais comme étant *vidua* Klug ♀ (1), avec un certain doute cependant, la description de Klug se rapportant au mâle, et ne comportant que des couleurs sans aucun détail de structure ; plus tard la capture d'un exemplaire ♀ de *Cerceris insignis* Klug me fixa, car la description de *insignis* faisait état de la sculpture caractéristique de l'aire cordiforme du segment médiaire.

Morice, en 1897, a eu en mains sans le reconnaître, le mâle de *alboatra* Walker ; la description qu'il en donne ne laisse aucun doute à ce sujet, mais, se basant sur une opinion émise par Kohl, il croyait avoir affaire à *vidua* ♂, et en complète la description. Or, assimiler *alboatra* à *vidua* ne me paraît pas acceptable : Walker cite un caractère décisif que ni Kohl ni Morice n'auraient dû négliger : « the petiole is much more slender than that of *vidua* ».

Cerceris vidua Klug doit être autre chose, d'allures générales semblables à celles d'*alboatra*, sauf en ce qui concerne le pétiole (et peut-être d'autres caractères).

Je crois bien avoir retrouvé cette espèce dans une série de mâles, une douzaine environ, du Gebel Asfar, en Avril-Mai.

Noir, avec les dessins du corps blanc-jaunâtres et la coloration des pattes semblables à ceux de *alboatra*.

Pétiole noir, très peu plus long que large. L'ensemble du corps d'allure moins élancée que *alboatra*. Hanches antérieures normales.

Clypeus pentagonal, nettement bombé au milieu. Yeux paralèlles. Le deuxième segment est moins étiré à la base ; il n'y a pas de plaque basilaire ventrale, mais un très léger renflement nodiforme mal délimité. Avant-dernier sternite denticulé, par contre, le tergite correspondant ne porte pas de dent latérale.

Ponctuation générale assez forte et plutôt serrée, sauf sur le mesonotum et le scutellum, qui sont même assez brillants chez quelques individus. L'aire

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(1) Dans le catalogue de D'alla Torre, il y a l'indication suivante que je n'ai pu contrôler : *C. vidua* Ritsema, Tidjschrift voor Entomologie, 1874, p. 298, numéro 17, ♀.

cordiforme me paraît caractéristique : elle est lisse sur la surface et présente le long de la base une bande régulière de hachures courtes et serrées, comme on en voit chez *tricolorata* Spin. d'après la figure 17 de la planche X de Mochi, mais plus large, au moins un quart de la hauteur du triangle.

Ce ne peut être *tricolorata* elle-même : celle-ci a une plaque basilaire petite mais bien marquée au deuxième sternite ; d'après la figure la surface de ce sternite n'est pas marquée de gros points sur le disque ; le pétiole est plus large que long, et la ponctuation est très espacée sur le dos du thorax ; subsidiairemnt, le nombre des bandes jaunes à l'abdomen est différent, ainsi que l'importance du développement de la coloration rouge.

Il y a une variation à pétiole rouge, chez laquelle les bandes claires sont encore plus blanchâtres que chez les individus à pétiole noir. A première vue elle a un autre aspect, mais aucun caractère spécial ne permet de la séparer de la forme à pétiole noir. Peut-être avons-nous là *contigua* Walker?

A vrai dire, l'assimilation de cette espèce à *vidua* Klug n'est rien moins que prouvée ; elle est « probable » à mon avis et rien ne s'y oppose, mais on pourrait tout aussi bien l'affubler d'un nom nouveau.

En l'absence du sexe femelle, je préfère ne pas surcharger la nomenclature d'un synonyme possible ; jusqu'à preuve du contraire, je considère cette espèce comme étant *vidua* Klug (avec un point d'interrogation).

Cerceris insignis Klug.

Décrit de « l'Arabie heureuse ». J'en ai pris une femelle, en Juillet, à Hawamdieh, sur les inflorescences de poireaux, en même temps que *alboatra* Klug. L'exemplaire correspond bien à la description : répartition des colours, pilosité blanche longue et bien fournie. L'aire cordiforme du segment médiaire pourrait peut-être ne pas correspondre exactement, mais ceci me paraît plutôt une question d'interprétation des termes employés.

La description dit : « Metathorax sanguineus, plaga baseos triangularis media laevi, basi longitudinaliter elevato-lineata, nigra ». Dans l'insecte en question, l'aire triangulaire est rouge, lisse dans sa moitié postérieure (vers la pointe), marquée dans sa moitié basilaire de 7 à 8 sillons, disposés en long et de dimensions inégales, et qui vues sous un certain angle paraissent être, non pas des sillons, mais de fines carènes paralèlles, dont les intervalles feraient figure de sillons.

Morice, en 1911 redécrit *Cerceris insignis*, en lui assimilant, comme synonyme douteux, *tricolorata* Spin.. En réalité, *insignis* sensu Morice est la vraie *tricolorata*, telle que le Dr. Mochi l'a comprise et décrite.

Pour moi, *insignis* ♀ Klug ne serait pas autre chose qu'une variation sexuelle d'*alboatra*. Aspect général, structure des pattes, ponctuation, et surtout la forme très spéciale du pénultième segment ventral, les arguments ne manquent pas pour justifier cette réunion, d'autant plus que parmi les nom-

breux specimens de *alboatra* qui m'ont passé sous les yeux, j'ai pu constater la présence de formes indiquant une tendance au développement de la coloration rouge sur le segment médiaire et sur le pétiole. Les deux seuls caractères différentiels resteraient la pilosité beaucoup plus abondante que chez les exemplaires les plus frais de *alboatra* et les détails de sculpture de l'aire cordiforme.

On peut donc considérer *insignis* Klug comme une variation de *alboatra;* seulement alors, de par les lois de priorité *insignis* deviendrait nom spécifique, et *alboatra* serait ramené au rang de variété ; or, *alboatra* est certainement mieux et plus sûrement connu que *insignis*, encore une de ces conclusions contraires au bon sens auxquelles nous mène l'application aveugle des dites lois.

En attendant, le bon sens bénéficiera du point d'interrogation dont nous pouvons, jusqu'à plus ample informé, gratifier la synonymie en question.

Cerceris Honorei Mochi.

Je puis donner la description du mâle, resté inconnu au Dr. Mochi.

♂.—Long. : 7,5 à 8,5 mm.

Noir, à premier segment abdominal brun-rouge clair. Sont colorées en jaune franc les parties suivantes : la face, les mandibules (à pointe rembrunie), le bord interne des yeux et la carène inter-antennaire, le scape des antennes, et le dessous du funicule (le dessus est rougeâtre), deux points derrière les yeux ; le pronotum, les écaillettes, deux taches mésosternales, le scutellum et le post-scutellum, deux grandes sur la partie déclive postérieure du segment médiaire ; une petite tache transversale au bord postérieur du postérieur du pétiole, une bande basilaire au deuxième segment, les troisième, cinquième et sixième en entier, les bandes des deuxième et troisième segments se continuant sur la face abdominale.

Pattes jaune clair, les fémurs postérieurs plus ou moins rembrunis, les intermédiaires légèrement teintés.

Cette coloration est constante, sauf les taches mésosternales qui disparaissent chez 2 des 6 individus examinés.

Ailes enfumées dans leur tiers terminal, à partir de la deuxième cubitale.

Clypeus non aplati, plutôt bombé ; yeux légèrement divergents vers le bas ; carène inter-antennaire bien marquée.

Pronotum comme chez la femelle, avec la petite épine à l'angle latéro-inférieur. Ponctuation marquée, mais assez éparse pour laisser les téguments plus ou moins brillants, surtout le scutellum et le post scutellum qui peuvent être lisses, le segment médiaire également assez brillant. Aire cordiforme en

triangle aigu comme chez la femelles, lisse, avec un sillon médian bien marqué.

Pétiole très allongé, deux fois plus long que large, brillant, à ponctuation eparse ; celle-ci est plus dense sur le dessus de l'abdomen, tout en n'étant pas très serrée ; le dessous de l'abdomen est peu ponctué, le deuxième sternite étant même presqu'entièrement lisse. Deuxième segment étiré en col comme chez *alboatra ;* plaque basilaire du deuxième sternite petite mais bien marquée. Avant-dernier degment non denticulé. Aire pygidiale légèrement échancrée à son extrémité.

Type : Hawamdieh, en Mai.

La longueur inusitée du pétiole rapprocherait cette espèce de *alboatra ;* mais, en dehors de l'aire cordiforme, la présence d'une plaque basilaire au deuxième sternite et l'absence des épines latérales du pénultième sternite l'en éloignent nettement.

Je possède de cette espèce trois individus femelles très intéressants. L'un présente une coloration très semblable à celle décrite par le Dr. Mochi, qui a vu l'insecte et confirmé la détermination. Les deux autres ont une coloration identique à celle des mâles, telle qu'elle est détaillée plus haut (une de ces femelles a également été déterminée par l'auteur lui-même). Donc, sur 9 exemplaires des deux sexes, un seul, une femelle, correspond au type unique décrit.

Or, précisément ce spécimen m'avait toujours intrigué. Je possédais cette femelle depuis bien longtemps (6 Juin 1924) et je la considérais comme pouvant être *histrionica* Klug. La correspondance des couleurs est très exacte, et Klug la déclarait « *Philantho fisheri* Spin. proximus » (*Philanthus* pour *Cerceris*). En effet, il y a une certaine ressemblance, mais assez vague.

Je m'étais heurté à une phrase de la description de Klug : « punctis plurimis sat magnis impressis scaber » (scaber = rugueux) ; il n'y a pas de *Cerceris* de ce groupe qui soit rugueux de par la ponctuation, aussi ai-je toujours supposé qu'il y avait là un lapsus calami de la part de Klug ; peut-être un jour trouvera-t-on que *Honorei* = *histrionica* Klug.

Quoi qu'il en soit, j'en possède 9 individus, 3 ♀♀ et 6 ♂♂, de Hawamdieh, en Avril-Juin, sur les inflorescences du fenouil cultivé (*Fœniculum capillaceum* Gilib.).

Cerceris subimpressa Schlett., 1887.

Le Dr. Mochi a méconnu cette espèce, probablement parce qu'il la connaissait mal en nature, et l'a réunie à *Cerceris Fischeri*. Il dit s'être basé sur la comparaison et l'étude des descriptions, mais comment a-t-il pu assimiler une espèce à yeux divergents avec une autre à yeux paralèlles ?

Cerceris subimpressa n'est pas une espèce xérophile, ni même du désert

en bordure des régions cultivées, comme Sakkara par exemple ; elle me paraît se rencontrer exclusivement dans la zone des cultures ; les nombreux exemplaires que j'ai pris viennent tous des jardins et terrains cultivés autour de Hawamdieh, où cette espèce, qui doit être hygrophile, trouverait les conditions d'existence voulues ; la plante favorite, pour ne pas dire exclusive, est la « libia » (*Lippia nodiflora* Rich.).

Voici d'abord le système de coloration.

♀.— Noire, marquée de jaune, le pétiole noir. Sont de couleur jaune franc les parties suivantes. La face, les mandibules (à pointe rembrunie), les orbites internes des yeux et la carène inter-antennaire ; le scape des antennes (le funicule étant orangé clair en dessous et brun-rouge en dessus) ; deux taches de chaque côté du pronotum, les écaillettes, le post-scutellum ; une grande tache basilaire au deuxième segment de l'abdomen, le troisième jaune en entier, moins une échancrure en demi-cercle au bord antérieur, le cinquième segment jaune en entier ; la bande jaune du troisième segment se continue en dessous sur toute la surface du sternite, les quatrième et cinquième sternites ne sont que tachés de jaune sur les côtés.

Pattes d'un jaune légèrement orangé, l'articulation des fémurs postérieurs avec leur tibia est brun-noir.

♂.— Comme la femelle, mais d'un jaune plus clair ; sixième segment jaune en dessus ; sur la face ventrale de l'abdomen, la bande jaune correspondant à celle du troisième segment subsiste seule, les taches latérales des quatrième et cinquième sternites ont disparu ; les fémurs postérieurs sont d'un brun-noir sur toute leur face interne.

Ailes légèrement teintées sur leur surface, quelque peu rembrunies le long du bord antérieur et à la pointe.

La variation de coloration est nulle chez les 9 mâles de ma collection, minime chez la femelle, elle se borne à l'apparition d'un mince trait jaune, pouvant encore être scindé en deux taches sur le scutellum, et, très rarement, quelques petites taches jaunes sur le bord postérieur du quatrième segment de l'abdomen. En tout cas, parmi les nombreux exemplaires examinés, je n'en n'ai pas trouvé un seul ayant le pétiole rouge, par contre, tous les *Fischeri* que j'ai vus, une cinquantaine au moins, tous avaient le pétiole rouge. Encore ceci : chez *Fischeri* ♀, la bande colorée du cinquième segment n'est pas jaune mais d'un blanc d'ivoire ; sur le vivant la différence est très nette et permet de reconnaître l'espèce au premier coup d'œil. Sur les insectes tués au moyen du cyanure ou de l'acétate d'éthyle (employé par le Dr. Mochi) ce blanc tourne au jaune, et cela change complètement l'aspect de l'insecte. L'expérience m'a appris que les blancs et les jaunes blanchâtres des Sphégides et des Vespides sont sensibles à l'influence de l'acétate d'éthyle qui les jaunit, surtout si le contact est quelque peu prolongé.

Le système de coloration présente donc des différences constantes entre les deux espèces : il suffit de comparer une vingtaine de *subimpressa* avec une série pareille de *Fischeri* pour être édifié.

En dehors des différences de coloration, il y a encore assez de caractères de structure permettant de distinguer les deux espèces. Ci-après un tableau comparatif donnant les caractères essentiels.

Cerceris subimpressa	*Cerceris Fischeri*
♀	♀
Bord internes des yeux divergents vers la base.	Bords internes des yeux paralèlles.
Face sous les antennes plus large que haute.	Face sous les antennes aussi haute que large
Aire cordiforme bien délimitée. Sillon médian et bords latéraux marqués par de microscopiques hachures.	Aire cordiforme, pourvue de sutures latérales peu marquées, ainsi que que le sillon médian.
Région du segment médiaire bordant l'aire cordiforme à ponctuation de densité moyenne, égale à celle du restant du segment. Aspect peu brillant.	Région du segment médiaire bordant l'aire cordiforme à ponctuation très espacée. Aspect très brillant.
Deuxième sternite imponctué au milieu, devant la plaque basilaire.	Deuxième sternite ponctué à gros points allongés sur toute la surface.
Protubérances latérales du cinquième sternite arrondies en bosses, séparées par un bord droit.	Protubérances latérales du cinquième sternite proéminentes en dehors, presque pointues, séparées par un sinus.
♂	♂
Avant-dernier sternite simplement anguleux sur les cotés.	Avant-dernier sternite nettement denté, les dents visibles par dessus.

Les femelles sont faciles à distinguer, les mâles le sont moins. Chez ceux-ci, les caractères de structure sont moins nets, mais en dehors des angles plus ou moins émoussés du sixième sternite, il reste toujours pour caractériser *subimpressa* l'aire cordiforme moins lisse et mieux définie, surtout le sillon médian plus profond ; aussi la largeur relative de la face et dans une certaine mesure, la coloration noire du pétiole.

Hawamdieh, assez commun de Mars en Mai, sur *Lippia nodiflora* Rich.. *Fischeri* se prend dans les mêmes endroits, mais plus tard dans la saison,

en Mai-Juin, volant plutôt sur certaines Labiées odoriférantes, le basilic (*Ocimum basilicum*) et le romarin (*Rosmarinus officinalis*).

Cerceris Klugi Schlett., 1887 (*annulata* Klug, nec Rossi).

Cette espèce est décrite d'Assouan.

J'en ai pris une femelle à Sakkarah, le 1er Juin 1934. Elle correspond bien à la description que donne Schletterer, sauf en ce qui concerne les bandes jaunes des troisième et quatrième segments dorsaux de l'abdomen, qui sont ici très larges sur les côtés, mais nettement interrompues au milieu, alors que Schletterer les dit plus ou moins échancrées.

Ce système de coloration dans lequel chez la femelle, tous les segments, depuis le deuxième, et le quatrième y compris, portent une bande jaune, est tout à fait anormal pour l'Egypte. Dans le même genre, il y a *Schmiedeknechti* Kohl, mais ici le clypeus a une forme assez particulière, et le pétiole est beaucoup plus large; il pourrait y avoir certaines formes à bandes jaunes réduites de *Cerceris Alfierii*, mais cette espèce a des hanches coniques très caractériques, alors que *Klugi* ou tout au moins le spécimen que j'ai sous les yeux, a les hanches normales, tronquées carrément.

Quant au mâle, je suis bien dans le doute; le Dr. Mochi a inséré, sans commentaires, dans sa table de détermination, une espèce qu'il suppose être *Klugi* ♂; il est regrettable qu'il n'ai pas cru devoir en donner une description un peu plus substantielle.

Je possède 2 mâles de Hawamdieh qui ressemblent étonnement à la ♀ dont il est question ci-dessus; je ne crois pas que l'on puisse l'assimiler à cette espèce, car Schletterer dit expressément : « Segmenta abdominis ventralia lateraliter evidenter angulata » (tous les segments), ce qui ne se vérifie nullement sur mes specimens. Ce n'est pas *emarginata* Panz., bien qu'ils y ressemblent. Peut-être y a-t-il là une espèce nouvelle.

Cerceris lateriproducta Mochi.

Hawamdieh, 4 ♀♀ et 3 ♂♂ en Juin; une ♀ en Septembre. Je cite cette espèce surtout pour relever le fait que la figure coloriée N° 14 ♀ de la planche II du Dr. Mochi n'est pas très fidèle : les dessins jaunes du corps, (à l'exclusion des pattes) ne sont pas jaunes, mais d'un blanc d'ivoire, ce qui donne à l'insecte un aspect tout différent.

Cerceris Schmiedeknechti Kohl, 1898, ♂ ♀ (Ann. K.-K. Naturhist. Hofmus. Wien).

Décrit de Hélouan. Le Dr. Mochi n'en fait pas mention. Je ne la connais pas de visu; il faut bien espérer que cette espèce se retrouvera un jour, également *albicincta* Schlett.

Schletterer signale *eugenia* Schlett. (*orientalis* Mor., nec Smith) comme existant en Egypte; il y a peut être une erreur.

Quant aux trois espèces de Dahlbom: *histrio, dispar* et *solitaria*, comme les trois espèces de Spinola citées plus haut: *flaviventris*, *chlorotica* et *Waltli*, on peut les considérer comme étant actuellement indéchiffrables; je serais assez d'avis de les rayer définitivement.

Ci-après des Tables pour la détermination des espèces égyptiennes, établies d'après celles du Dr. Mochi, avec les quelques modifications rendues nécessaires.

Tables pour la détermination des espèces

♀♀

1. Bord antérieur de la partie médiane du clypeus nettement détaché sur toute ou partie importante de sa longueur, la partie médiane elle-même plus ou moins relevée en auvent ou sous forme d'une crête transversale 2

—. Partie médiane du clypeus à bord antérieur non détaché sur une partie importante de sa longueur, mais pouvant présenter en son milieu des protubérances coniques plus ou moins marquées 3

2. Partie médiane du clypeus libre, relevée en auvent, bombée, épaissie, échancrée en arc à son bord antérieur. Ailes complètement enfumées. Longueur 25-30 mm. ..... *erythrocephala* Dhlb.

—. Bord antérieur de la partie médiane du clypeus libre, non apprimé, nettement relevé sous forme d'une crête transversale, la partie médiane elle-même restant aplatie. Ailes légèrement enfumées, obscurcies le long de la côte et au bord antérieur de l'aile. Longueur 10-12 mm. .... *rutila* Spin.

3. Aire pygidiale striée longitudinalement, brillante. Coloration rouge et noire ..... *sulcipyga* Mochi

—. Aire pygidiale non striée longitudinalement 4

4. Pénultième sternite portant une impression médiane limitée en arrière par un rebord saillant 5

—. Pénultième sternite sans impression médiane 6

5. Deuxième sternite portant une plaque basale lisse, faisant saillie .... *tricolorata* Spin.

—. Deuxième sternite sans plaque basale ..... *alboatra* Walk.

6. Angles postico-latéraux des tergites dilatés en un petit appendice aigu.. 7

—. Angles posticaux-latéraux des tergites droits ou arrondis 8

7. Coloration foncière noire, dessins du corps blancs et rouges .... *lateriproducta* Mochi

—. Coloration jaune dominante ..... *lateriproducta* var. *flava* Mochi

8. Tempes munies en dessous d'une dent spinoïde forte et aiguë .... *Komarowi* Radszk.

—. Tempes inermes 9

9. Deuxième sternite sans plaque basilaire 10

—. Deuxième sternite présentant une plaque basilaire, qui peut être très réduite (*pallidula*) 14

10. Mésopleures sans épine. Taille petite, 7-9 mm. 11

—. Mésopleures armées d'une épine plus ou moins aiguë. Taille dépassant 12 mms. 12

11. Aire pygidiale en trapèze. Tarses postérieurs courts par rapport à leur tibia ..... *pharaonum* Kohl

—. Aire pygidiale en ovale allongé. Tarses postérieurs longs par rapport à leur tibia ..... *pallidula* Morice

12. Clypeus absolument plat. Aire cordiforme lisse, avec un sillon médian. Tarses postérieurs courts par rapport à leur tibia ..... *lutea* Tasch.

—. Clypeus relevé en cône en avant. Aire cordiforme nettement striée sur toute la surface. Tarses postérieurs longs par rapport à leur tibia. .. 13

13. Téguments très finement ponctués. Une seule épine mésopleurale. Tête de largeur normale. Longueur 13 mm. ..... *Döderleini* Schulz

—. Téguments fortement et densément ponctués. Deux épines mésopleurales. Tête de largeur énorme. Longueur 16-20 mm. ..... *capito* Lep.

14. Coloration foncière jaune 15

—. Coloration foncière noire, à dessins jaunes ou rouges. 19

15. Une épine mésopleurale 16

—. Pas d'épine mésopleurale 17

16. Partie médiane du clypeus légèrement concave sur les deux-tiers inférieurs. Deuxième article du funicule à peine plus long que le premier .. .. *pulchella* Kl.

—. Partie médiane du clypeus portant une petite bosse en forme de pyramide. Deuxième article du funicule deux fois plus long que le premier. ..... *Priesneri* Mochi

17. Clypeus déprimé sur la moitié inférieure de sa surface, légèrement creusé vers son bord antérieur. Hanches antérieures ayant un prolongement conique atteignant, en longueur, presque la moitié du trochanter .... *Alfierii* Mochi

—. Clypeus plus ou moins convexe, non déprimé ni creusé. Hanches antérieures normales 18

18. Clypeus à bord antérieur droit. Plaque basilaire du deuxième sternite très réduite ..... *pallidula* Morice

—. Clypeus à bord largement échancré. Plaque basilaire du deuxième sternite bien développée ..... *pruinosa* Morice

19. Une épine mésopleurale longue et aiguë. Aire cordiforme allongée, la hauteur du triangle étant beaucoup plus grande que sa largeur à la base. ..... *Honorei* Mochi

—. Pas d'épine mésosternale. Aire cordiforme de dimensions normales.. 20

20. Hanches antérieures normales. Des bandes jaunes ou des taches jaunes latérales sur chacun des segments abdominaux ..... *Klugi* Schl.

—. Hanches antérieures ayant un prolongement conique (cf. N° 17) 21

21. Deuxième sternite non ponctué sur le disque, devant la plaque basilaire. Aire cordiforme à bords et sillons nettement marqués. *subimpressa* Klug.

—. Deuxième sternite ponctué au milieu comme sur les côtés 22

22. Aire cordiforme bien délimitée, couverte d'un pointillé très fin, mais bien visible, les côtés marqués par de petits sillons transversaux. Coloration générale noire et jaune, pétiole entièrement noir ou taché de jaune. ..... *Alfierii* var. *picta* Mochi

—. Aire cordiforme mal délimitée, très lisse, sauf un fin sillon médian. Coloration variée, noire à bandes jaunes, le pétiole rouge, le cinquième segment de l'abdomen blanc..... *Fischeri* Spin.

♂♂

1. Clypeus convexe dans sa partie supérieure, avec, dans sa partie inférieure, une forte carène longitudinale bien marquée, atteignant le bord antérieur du clypeus ..... *Döderleini* Schulz

—. Clypeus autrement conformé 2

2. Métatarse intermédiaire nettement recourbé. ..... *capito* Lep.

—. Métatarse intermédiaire droit 3

3. Cinquième sternite creusé à sa base d'une concavité en demie-lune tournée vers l'arrière ..... *Komarowi* Radszk.

—. Pas de concavité en demie-lune sur le cinquième sternite. 4

4. Angles postico-latéraux des tergites légèrement dilatés. 5

—. Angles non dilatés 6

5. Tête et thorax noirs à dessins jaunes ; abdomen jaune avec tous les segments offrant une mince bande noire terminale. .. *lateriproducta* Mochi

—. Coloration jaune très dominante .. .. *lateriproducta* var. *flava* Mochi

6. Tarses postérieurs, pris dans leur ensemble, à peine plus longs que leur tibia : Tarses III/Tibia III = 1,1. Aire pygidiale de forme trapézoïdale. 7

—. Tarses postérieurs pris dans leur ensemble, nettement plus longs que leur tibia : Tarses III/Tibia III = 1,5. Aire pygidiale non trapézoïdale. 9

7. Grande taille, longueur 14 mm. Tête et thorax noirs avec quelques dessins rouges, abdomen rouge. Pattes très épineuses.... *sulcipyga* Mochi

—. Taille moyenne ou petite, 7 à 12 mm. Coloration jaune dominante. Pattes peu épineuses 8

8. Bord antérieur du pronotum normal. Clypeus à bord antérieur droit, plus fortement et densément ponctué. Longueur 10-12 mm. .... *lutea* Tasch.

—. Bord antérieur du pronotum denticulé de chaque côté. Clypeus a bord antérieur flexueux, à ponctuation plus fine et plus espacée. Longueur 7-9 mm. ..... *pharaonum* Kohl

9. Pas de plaque basilaire au deuxième sternite. 10

—. Une plaque basilaire au deuxième sternite. 14

10. Aire cordiforme portant, sur toute ou presque toute sa surface, de forts sillons bien marqués, disposés en longueur 11

—. Aire cordiforme marquée autrement 12

11. Pétiole étroit, deux fois aussi long que large. Avant-derniers tergite et sternite tous deux anguleux de chaque côté ..... *alboatra* Walker

—. Pétiole court, guère plus long que large. Derniers segments de l'abdomen non denticulés ..... *rutila* Spin.

12. Longueur 8-9 mm. Ailes hyalines, sauf à la pointe. Abdomen à bandes jaunes, sauf au pétiole et au quatrième segment. ..... (?) *vidua* Klug

—. Espèce de grande taille. Ailes très enfumées. Autrement coloré 13

13. Tête et thorax noirs avec quelques dessins ou points jaunes ou rouges; pétiole noir ou rouge, les autres segments jaunes avec une mince bande noire ou d'un brun foncé au bord terminal..... *erythrocephala* Dhlb.

—. Abdomen tout noir, le pétiole rouge. ..... *erythrocephala* var. *gynochroma* Mochi

14. Aire cordiforme allongée, lisse. Pétiole deux fois aussi long que large.. ..... *Honorei* Mochi

—. Aire cordiforme de forme normale. Pétiole moins allongé 15

15. Plaque basilaire du deuxième sternite triangulaire, très petite, coloration dominante jaune ..... *pallidula* Morice

—. Plaque basilaire du deuxième sternite bien développée..... 16

16. Hanches antérieures prolongées par un appendice conique 17

—. Hanches antérieures normales 19

17. Prolongement conique des hanches antérieures très développé, égalant presque la moitié du trochanter. Coloration noire et jaune, celle-ci dominant sur l'abdomen ..... *Alfierii* var. *picta* Mochi

—. Prolongement conique des hanches antérieures court, égalant le quart de la longueur du trochanter. Noir à bandes abdominales jaunes assez réduites, nulle sur le quatrième segment 18

18. Sixième sternite denticulé de chaque côté. Aire cordiforme lisse et mal délimitée. Face plus haute que large. Pétiole rouge..... *Fischeri* Spin.

—. Sixième sternite non denticulé. Aire cordiforme nettement délimitée sur

les côtés, son sillon médian profond. Face plus large que haute. Pétiole noir ..... *subimpressa* Klug

19. Deuxième article du funicule des antennes au moins deux fois plus long que le premier ..... *Priesneri* Mochi

—. Deuxième article des antennes pas ou guère plus long que le premier.. 20

20. Aire cordiforme ponctuée au moins sur sa moitié inférieure, terne. Coloration entièrement jaune ..... *pruinosa* Morice

—. Aire cordiforme lisse, brillante 21

21. Abdomen jaune. Ponctuation du mésonotum éparse. Aire cordiforme avec un sillon médian ..... *pulchella* Klug

—. Abdomen noir ou plus ou moins rouge, à bandes d'un jaune pâle. Ponctuation du mésonotum assez dense. Aire cordiforme sans sillon médian. ..... *tricolorata* Spin.

NOTA.—Je n'ai pas compris dans les Tables, le *Cerceris Schmiedeknechti* Kohl, ni l'*albicincta* Schlett. qui ne me sont pas connus en nature.

Dans la Table des femelles, *Cerceris pallidula* se rencontrera deux fois : l'extrême petitesse de la plaque basilaire du deuxième sternite chez cette espèce en rend l'observation pas toujours très nette, aussi ai-je cru bon de la citer dans les deux divisions.

Dans la Table des mâles, j'ai admis *Cerceris vidua* Klug avec un ?. Par contre, j'ai bien dû éliminer, faute de renseignements suffisants, *Cerceris Klugi* Schlett. sensu Mochi.

A study of the biology of the Egyptian common house-fly: *Musca vicina* Macq.

[Diptera : Muscidae]

(with 9 Text-Figures)

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I. INTRODUCTORY AND HISTORICAL

As the fly problem is now one of the important questions in Egypt for its close relation to the sanitation of the country and improving the hygienic and living conditions of the rural population, its has been found that a study of the biology of the Egyptian common house-fly *Musca vicina* Macq. which — among the class of obnoxious flies — is emphatically the predominant, is quite indispensable to a thorough comprehension of the fly question.

Reviewing the literature, it seems that, neither in Egypt nor in other countries, has an account been given by previous workers on the biology of *Musca vicina* Macq.. Patton (1933) alone has given in a very few lines some remarks on the breeding media of this species. He stated that it breeds in large collections of cow dung, but according to my observations (Hafez, 1939) it does not breed in Egypt in cow dung, but horse and donkey dung afford the chief breeding media of this species.

As regards *Musca domestica* L., the European common house-fly to which *Musca vicina* Macq. is related, a considerable amount of literature on the biology has been given by previous workers such as Gleichen (1790), Packard (1874), Newstead (1907), Howard (1911), Graham-Smith (1913), Hewitt (1914), Roubaud (1915), Austen (1928), Patton (1931), Thomsen (1934 and 1936). But with the exception of Thomsen, most of these workers have inadequately dealt with several points of paramount importance such as the power of attraction of different kinds of dung for ovipositing flies, the influence of temperature and humidity on the duration of larval stages and development, etc.

These points have been taken into consideration as regards *Musca vicina* Macq. by the present author.

II. MATERIAL AND TECHNIQUE

The dung of horse, cow, buffalo, pig, sheep, calf, and goat as well as human excrement was brought fresh from some farms, stables and middens, and distributed in special wooden frames and left exposed in the open for the ovipositing flies. The dung, after about six hours exposure, was taken to the laboratory and when development was completed the adult flies were collected and utilised for the various experiments. This procedure also helped in testing the power of attraction of these different kinds of dung for the ovipositing flies. In following the life-history and in estimating the rate of development, experimants were carried out in the laboratory. Glass tubes and vessels containing suitable amounts of dung were used. The eggs or sometimes the young larvae were placed in these tubes either at room temperature or in the thermostat and allowed to complete development.

The early stages were described from microscopical preparations. The young larvae were preferably killed by and mounted in Faure's mixture. For mature larvae the clearing produced by this method proved insufficient. Such larvae were transferred from alcohol to warm caustic potash and left there until they were sufficiently clear; they were then washed with water, dehydrated and mounted.

The figures of the larvae and their structure were drawn by the aid of the camera lucida.

III. BIONOMICS AND HABITS

1. Seasonal prevalence and local distribution

Musca vicina Macq. or the Egyptian common house-fly, is generally met with all the year round, but the period in which the fly shows itself in greatest abundance is the early summer (April, May and June) and the autumn (September) when the fly breeds very extensively. The temperature conditions in this period in Egypt are very favourable for breeding and development (28-35° C.). During the summer the temperature becomes sufficiently high to prevent oviposition and the development of the early stages; the temperature may rise to 50° C. or more in the sun, and consequently the flies tend to be less numerous in contrast to European countries in which the summer (July and August) is the season of the prevalence of *Musca domestica* L.

During the winter season in Egypt the flies become of uncommon occurrence and in January they become rare. From March, sometimes earlier, the breeding season begins and the number of flies gradually increases until it reaches its maximum in May and June.

The local distribution is mainly dependant on the presence of favourable breeding media and the access of the fly to them. Such access differs with the different localities. As a rule, the common house-fly is not so widely distributed in Cairo and in the larger provicial towns as in the country. It has been previously pointed out by the auther (Hafez, 1939) that in the region of Cairo and other large towns the horse stables, especially those of private people, play an important part in the production of the flies. The floor of such stables is generally covered with a fairly thick layer of dung which is always kept moist by absorbing the urine of the animal, and in this bedding larvae are found in extreme abundance. The other breeding substances of the house-fly such as the house refuse and other decomposing vegetable matter are much less important since in Cairo and towns better sanitary conditions than in the country are afforded.

In the country the flies are more abundant than in towns because of the wide distribution of dung and other breeding substances. Stables for donkey keeping which are most exclusively owned by private people and consequently not carefully looked after are very numerous in most of the Egyptian villages. These stables are generally not cleaned except occasionally at intervals of weeks or even of months, fresh litter, however is supplied frequently which absorbs the urine and affords a dry and soft bedding for the donkeys. The result is that the floor of the stable is provided with a layer often several inches thick of compact litter mixed with dung and urine only the surface being fairly dry. This thick layer affords a very favourable

breeding medium for the fly and always contains very great numbers of the fly larvae.

There is also another important breeding medium which contributes to a great extent to the wide distribution of the house-fly in the country. This medium is the human excrement which in the Egyptian villages, owing to lack of drainage systems and inadequate sanitary arrangements in the houses of farmers, affords a favourable place for the breeding and the production of flies. In several villages there are no water closets or cesspits of any sort in the houses and huge accumulations of human excrement frequently occur in the open.

Other decomposing vegetable matter, the refuse of houses are not got rid of by the people and in my opinion all these factors, together with the unhygienic conditions under which the rural population lives, have contributed to the wider and more extensive distribution of the common house-fly in the country than in the region of Cairo and towns.

2. Influence of temperature and light on the adult

The adult fly is directly influenced by temperature. At a moderately high temperature (28-35° C.) the fly assumes a pronounced activity, which, in Egypt is generally in the early summer and autumn. In the summer the fly activity is slightly reduced due to the high temperature which may reach over 40° C. in the shade and about 50° C. in the sun. In winter, the flies become quite inactive, but however they are able to withstand comparatively low temperature. As regards *Musca domestica* L., some previous workers carried out several experiments in which they submitted the fly to low temperature. Donhoff (1872) submitted *Musca domestica* L. to a temperature of — 1.5° C. for five hours and they continued to move. When the temperature was lowered to — 3° C. and the duration of exposure was prolonged to eight hours the flies moved their legs. After twelve hours exposure to a temperature first of — 3.7° C. and then — 6.3° C. the flies appeared to be dead, but they recovered when brought to warmth. The flies died completely when they were submitted for three hours to a temperature of —10° C. which was then raised to —6° C. Bachmetjew (1906) was able to submit *Musca domestica* L. to as low a temperature as —10° C. and vitality was retained, and the fly recovered when exposed to normal room temperature.

As regards *Musca vicina* Macq., I have performed a number of experiments and the conclusions arrived at involve that the fly can withstand a temperature which is as low as —7° C. with a maximal duration of exposure of six hours. At a temperature of —11° C. and exposed for three hours the flies die.

As regards the influence of light on the adult fly, it is obvious that the fly is attracted to light where it assumes its activity and lays its eggs. In very dark places usually oviposition does not take place. I have carried out several experiments in which the female flies were kept in a big glass vessel with an amount of pig dung and covered with muslin and then put in a dark room : it was noticed that in all the experiments but two, egg laying did not take place.

I have also carried some experiments to ascertain any colour preference by the flies by using large glass vessels, the walls of which were divided into several areas and these were painted each in a different colour. The conclusions arrived at makes me more inclined to believe that the flies did not display any marked colour preference.

But Galli-Valerio (1910) in his experiments on the question of colour preference showed that *Musca domestica* L. preferred the light colours such as the clear green, rose, clear yellow, clear red, etc.

Hindle (1913) pointed out that his experiments appeared to demonstrate that *Musca domestica* L. did not prefer a special colour.

3. Longevity of the adult

To determine the maximal duration in which *Musca vicina* Macq. can be kept alive in confinement several experiments have been carried out. From the results obtained it was found that the maximal duration differed according to the seasons of the year.

In the spring of 1939 (mainly in March) it was possible to keep 25 out of 34 flies alive in captivity for 46 days.

In the early summer of the same year (May) the maximum length of the life of the fly was 18 days.

During the summer (July, 1939) the flies died after 26 days.

In autumn (September, 1939) the flies were kept alive for 31 days. In October, the flies were able to live for 45 days and in winter, mainly in December, it was possible to keep the flies alive for 56 days. It happened that five flies were able to live in January for 70 days. From the results obtained, it is obvious that the maximum length of the life of the fly in captivity is usually attained in winter, mainly in December and January, while at the end of spring and advent of summer the longevity is brought to a minimum, that is probably due to the higher exertion or extreme activity of the fly during this season. In autumn, the life usually reaches to a moderate length. But it is quite likely that such data do not give an exact information about the real length of the natural life of the fly, since the conditions under which the fly lives in captivity are artificial and unnatural.

Other workers have previously carried out some experiments to deter-

mine the longevity of *Musca domestica* L.. Griffith (1908) was able to keep a male fly alive for sixteen weeks. Jepson (1909) succeeded in keeping alive for eleven and half weeks flies which had been reared in captivity in February. He adds that in the summer he was not able to keep the flies in captivity for more than three weeks. Hewitt (1914) states that he never succeeded in keeping flies alive in captivity for a longer period than seven weeks.

IV. BREEDING HABITS

1. Different breeding media

In 1935, when I started my study on the insect fauna of dung in Egypt, I laid more stress on investigating the different dung breeding media of some common flies especially *Musca vicina* Macq.. Five kinds of dung were chosen for study (cow, buffalo, camel, horse and pig dung). But I had not had the chance of studying other kinds of manure and investigating their importance as breeding media. Therefore, it was found advisable when studying the biology of *Musca vicina* Macq. to take into consideration the dung of calf, sheep and goats which are very widely distributed in Egypt and also to direct much attention to the possible practical importance of human excrement as a breeding medium. I have also borne in mind to take the advantage of this opportunity and confirm my previous observations made in 1937. My observations have been extended to about 146 farms, stables and other places. Only the main results of my observations and experiments will be given here, the details being described in my paper on «Investigations into the Problem of Fly Control in Egypt», which is published in this Bulletin, pages 99-144.

1. Horse manure

Observations on farms and stables in the region of Cairo and in towns as well as laboratory experiments have shown and definitely proved that horse manure under natural conditions is the most important breeding medium for *Musca vicina* Macq. and to a very great extent responsible for the fly production in Cairo and in towns. Most of the stables especially those owned by private people are not cleaned except occasionally at intervals of weeks or even of months. Fresh litter, however, is supplied frequently which absorbs the urine and affords a dry and soft bedding to the horses. The result is that the floor of the stable is provided with a layer about one foot thick, and of compact litter mixed with dung and wet with urine and only the surface being fairly dry. In this thick layer eggs and larvae of *Musca vicina* Macq. are found in extreme abundance. The temperature in this layer may account for that since it varies from 30-35° C. which is very suitable and

attractive to the egg-laying females. Also heaps of horse dung mainly those intended to be utilised as manure frequently occur in the open. Under conditions prevailing in Egypt such heaps afford a very suitable breeding medium for *Musca vicina* Macq.

The female fly may sometimes lay eggs on small masses of horse manure deposited in the fields, and hatch into larvae, but generally in this case horse manure is an unfavourable breeding medium since it soon dries up and any larvae present may perish. Also the fly will not oviposit in single horse droppings scattered in fields and on roads. Evidently they dry up too rapidly and are in addition broken up by birds.

2. Pig dung

Musca vicina Macq. breeds in pig dung. If the pregnant flies are free to choose they will concentrate on the pig dung which seem to have a greater attractive power for the ovipositing females than horse manure and also proved to be a more favourable breeding medium since it can retain its original texture, humidity, peculiar odour, etc., longer than horse manure partly at least owing to the fact that fermentation takes place more slowly. Generally, the pig sties are not carefully looked after and kept clean. The droppings of the pigs are allowed to stay a long time without being removed, and thus induce the oviposition of females and the favourable temperature of the dung also contributes to that.

3. Cow and Buffalo dung

Repeated investigations have confirmed the results previously obtained by the present author in 1937 (Hafez, 1939) that under Egyptian rural conditions *Musca vicina* Macq. will only exceptionally oviposit in pure cow or buffalo dung. That is probably due to some internal factors in the flies, also the temperature and the chemical and biological composition of dung, etc., may have something to do with the repugnance of the flies towards these kinds of dung.

4. Sheep and Goat dung

Owing to the wide distribution and extreme abundance of sheep and goats in the country in Egypt, there are special stables fitted exclusively for their keeping at night. My visits to these houses have clearly shown that sheep and goat dung, which is generally mixed with straw and litter, is a favourable breeding medium for *Musca vicina* Macq.. Prodigious numbers of larvae are met with in the layers of dung usually accumulated on the floor of these houses. Also the suitable temperature, humidity and food con-

ditions in these places contribute to the acceleration of the developmental period of the fly and favours the breeding activity.

5. Calf dung

This sort of dung seems to be of no importance as a breeding medium for the Egyptian common house-fly. Laboratory experiments have shown that it usually does not attract the flies for oviposition, thus resembling cow and buffalo dung.

6. Fowl dung

The common house-fly breeds in this kind of dung, although its attractive power for the ovipositing females is incomparable to that of other sorts of manure. Under natural condition this dung as a breeding medium is of no considerable importance since the droppings are usually of small size and dry up very rapidly. Only in cases where there is a very large number of fowls kept in the house of the farmer, it is found that the accumulated dung together with the decomposing vegetable matter, etc., may be a favourable breeding medium for the fly.

7. Human excrement

Thorough investigations near towns and in a large number of the Egyptian villages revealed the fact that human excrement is a very important breeding medium for the common house-fly and is to a great extent responsible for the fly production in several localities. In nearly all the villages, the drainage systems commonly found in towns are not available, and quite a large number of houses are not provided with water-closets of any kind and consequently the people make use of certain pans or vessels and when these are filled up, then they are emptied onto a heap of excrement outside or near the village. When these droppings were examined, it was found that they harbour very large numbers of larvae of *Musca vicina* Macq., the adult flies being also seen in swarms hovering about the excrement and depositing their eggs on it. Single droppings usually met with in villages seem not to attract the ovipositing females. In one of the experiments the adult flies emerged in moderate abundance from human excrement after a period of development of about thirteen days which is an exceptionally long period of development probably owing to unfavourable conditions in regard to humidity and food.

8. House refuse

Usually, the fly breeds in this substance but not in abundance due to the possibility of being dried up very rapidly. Only when this refuse with decomposing vegetable and animal matter are collected and piled up in large heaps or public dumps the flies are attracted for oviposition in large numbers, and the larval development may be accelerated by the internal temperature, and favourable food conditions.

2. Breeding season

According to observations and experiments it was found that wherever food conditions and humidity are available, and a favourable temperature is present, the breeding activity becomes pronounced and the flies will lay their eggs, and the larvae will develop at any time of the year. But under natural conditions, the temperature differs with different months of the year. In Egypt, the most favourable temperature for fly breeding is in the early summer (April, May and June) and in the autumn (September) in which the flies assume a very pronounced activity in egg-laying and show themselves in very large numbers. In spring (February and March), flies occur in moderate abundance and the breeding activity is not pronounced. In summer (July and August), the temperature is sufficiently high (40-50° C.) to render oviposition and development not abundant. During the winter months (December and January), the breeding activity in the open is markedly diminished because of the low temperature. But in stables, pig sties, etc., the temperature may remain sufficiently favourable and allow the oviposition and the development of larvae to go on.

V. LIFE-HISTORY

1. Sex-ratio

Extensive observations in different localities of Egypt showed that in farms and stables, where accumulations of dung and decomposing matter afford a very suitable breeding medium, there is always a remarkable preponderance of females, and that mostly occurs in the early summer and autumn (September) when breeding activity attains its climax. It happened twice in a pig sty and a horse stable that the proportion of females to males present was 16 : 1. In the very early spring (February), generally the number of females is slightly less than that of the males. In and around houses, especially in towns, the ratio of sexes is nearly equal, sometimes the females sligthly exceed the males in number. As regards *Musca domestica* L., Hammer (1909) found that in the early summer the males were slightly in the

majority. Herms (1911) mentioned that near the breeding places the females exceed the males in number. Hewitt (1914) stated that the number of the females is approximately equal to that of the males.

2. Sexual maturity

To find out the length of the period extending from the time when the fly emerges from the pupal case until it becomes sexually mature and able to lay eggs, several experiments have been carried out it the laboratory. In one of the experiments (April, 15th 1939) 26 third stage larvae of *Musca vicina* Macq. were placed in a glass vessel with a suitable amount of pig dung and covered with muslin. The larvae were left to pupate and in about three days the adult flies emerged. These were transferred to another glass vessel with fresh pig dung. The dung was changed every two days. It was noticed that the flies became sexually mature and some females were seen to copulate with the males after about five days at room temperature (25-30° C.). Some of these impregnated females started laying eggs two days after copulation, some others three days. In other experiments carried out in May 1939, at 31° C., the flies became sexually mature and then copulated in about three days and started oviposition two days after, sometimes the whole period was prolonged and the flies began to lay eggs in nine days after their emergence from the puparium. But it should be pointed out that under natural conditions and at the very favourable temperature in Egypt, especially in the early summer (30-37° C.), the duration of sexual maturity is very likely to be considerably shorter than that found out in the experiments. As regards *Musca domestica* L., Hewitt (1914) stated that the flies became sexually mature in ten to fourteen days after their emergence from the pupal case and four days after copulation they began to deposit their eggs. Such a long period of development has never been recorded in my experiments with *Musca vicina* Macq.

3. Oviposition

Oviposition frequently occurs during the hot period of the year, and reaches its maximum in the breeding season which is here the early summer (April and May) and autumn (September) when the flies are seen in extreme abundance settling on the various kinds of dung and other breeding media. The eggs are laid by the females shortly after copulation. They are deposited on different food and breeding substances of which horse manure and pig dung, if the latter is in access, are the most preferable media for the ovipositing flies. When the female settles on the dung, it slightly bores its way in its substance, and in a small concealed crevice away from the light it

deposits its eggs by extending its ovipositor. When the process of egg-laying is finished, the eggs are generally covered by dung and thus protected from becoming dry. In some cases, especially in horse and donkey stables and in pig sties where no strong light occurs, the eggs are deposited on the surface of dung especially at the corners and near the side walls of the stable. The eggs are laid in masses or clusters and usually are closely grouped together.

4. Duration of the egg-stage

According to my experiments, in which several eggs of *Musca vicina* Macq. were allowed to hatch at different temperatures, it was found that the duration of the egg-stage differed widely as shown from the measurements and readings given in Table I.

TABLE I

TEMPERATURE IN °C.	DURATION OF EGG-STAGE IN HOURS
35-38 (mainly 36)	6
30-35 (mainly 32)	8
25-30 (mainly 28)	11
20-25 (mainly 22)	18
15-20 (mainly 17)	30
10-15 (mainly 12)	40

5. Larval moults and duration of the larval stages

The egg hatches into the first stage larva in about 11 hours at room temperature (25-30° C.). This larva is a very small creature crawling very sluggishly in the substance of the dung and feeding on it. It grows in size rapidly and in about 15 hours after hatching at a temperature of 30-33° C. it undergoes ecdysis. When the temperature was lowered to 25° C. the duration of the first larval stage was about 20 hours. In Egypt, where the temperature and food conditions are very favourable usually, the duration does not exceed 20 hours, in several cases, especially in summer, it is always about 15 hours and sometimes less. Moulting begins in the anterior region of the larva which gradually gets rid of its old skin together with the anterior cephalopharyngeal skeleton.

The first larval stage is followed by the second larval stage in which the larva is distinctly bigger and slightly more active, and in about 20 hours. at a temperature of about 30° C., it undergoes ecdysis and leads to the third stage larva. It happened in one of the experiments that the duration of the

second larval instar was as short as 16 hours at a temperature of 31° C. With lower temperature (20-25° C.), it was prolonged to about 30 hours.

In the third or last larval stage, the larva grows very rapidly and attains a much larger size than in the previous stages. It is more active and crawls about in the different parts of the dung, escaping always the strong light, and is seen always in large numbers at the deepest layers of the dung mass, sometimes (especially in summer) on the surface of the soil just below the dung where more humidity and lower temperature are available. Very rarely the larvae occurred near the surface layers, that was apparently due to the very high summer temperature in Egypt (about 40° C. in the shade and 50° C. in the sun). At a temperature of about 30° C., this larval stage lasted about two days, and when the temperature was lowered to 25° C. it was prolonged to about three days after which the larva pupated. To sum up the total duration of the larval stage it can be said that at a temperature of about 30° C. the three larval stages last about three days and a half, and such duration may be liable to a further shortening with more favourable food conditions and a slightly higher temperature.

6. Pupal stage

Usually, when the larva approaches pupation it turns creamy-white in colour, stops feeding and becomes very sluggish in movement and finally contracts, the anterior end being drawn in with the consequence that a more or less cylindrical puparium is formed. It should be pointed out that in the majority of dung masses examined the larvae (prior to pupation), always leave the surface and middle layer of the dung and escape to the deepest regions near the soil, and in many cases they tunnel in the dung until they reach the surface of the soil just below the dung where they pupate. At a temperature of about 30° C., the pupal stage lasts about three days. At 26° C. it was prolonged to four days after which the adult fly emerged.

7. Summary of duration of development

According to my results obtained under experimental conditions it was found that the shortest period for the duration of the whole life-cycle of *Musca vicina* Macq. is six days seventeen hours distributed as follows :

Egg stage	six hours.
First larval stage	fifteen hours.
Second larval stage	twenty hours.
Third larval stage	two days.
Pupal stage	three days.

These short durations were taken at a temperature of about 30° C., sometimes slightly higher, but it is very likely that under natural conditions the development is accomplished in less than six days seventeen hours since the internal temperature and the food conditions in the breeding media are more favourable. Under unfavourable food conditions and at a lower temperature, about (25° C.), the total duration of the life-cycle may be prolonged to nine days or more. But generally such long duration which is obtained under pure experimental conditions does not frequently occur in nature in Egypt. As regards the minimum duration of the whole life-cycle of *Musca domestica* L., Howard (1895) stated that according to his observations at Washington it was ten days. Newstead (1907) in his osbervations in Liverpool obtained a minimum duration of ten to fourteen days from the deposition of the egg to the emergence of the adult. Smith (1907) in India gives the rate of development in horse manure as eight days. Griffith (1908) in his experiments in South England recorded the duration as eight days. Hewitt (1914) stated that the minimum period of life history is eight days four hours. Thomsen (1934) in Denmark recorded seven days four hours, at 33° C.

β. Factors affecting development

Temperature, humidity and the nature of the larval food, etc., are undoubtedly very important factors which highly influence the rate development. Under experimental conditions at a temperature of about 30° C., it was shown that the duration of the whole life-cycle is six days seventeen hours, and when the temperature was lowered to 25° C. the duration was prolonged to about nine days. In some experiments which have been carried out in the open and in which pig dung was utilised as a breeding medium, it was found that development was completed in about ten days at an average, though not constant, daily temperature of 24° C.

In order to determine the influence of temperature on the development of the different stages of the life-history, a systematic investigation in thermostats has been carried out believing that this would be the one method likely to give precise data, since the internal temperature of the breeding media, e.g., manure heaps is subject to considerable variations. The results of my investigations which are carried out with pig dung are given in Table II.

It is now obvious from these data that wherever a continuous high temperature occurred there was a corresponding shortening in the different stages of the life-history. The shortest duration of development obtained is five days six hours at 38° C., and when the temperature was lowered the duration of all the stages was lengthened, the longest developmental period recorded is nineteen days eight hours at 13° C. In a few experiments, temperature as

high as 40° C. was used; but it was noticed that it has a very detrimental effect and a heavy mortality of larvae was recorded.

TABLE II

TEMPERATURE IN °C.	DURATION OF EGG-STAGE	DURATION OF FIRST LARVAL STAGE	DURATION OF SECOND LARVAL STAGE	DURATION OF THIRD LARVAL STAGE	DURATION OF PUPAL STAGE	TOTAL DURATION	
	hours	hours	hours	hours	hours	days	hours
38	5	12 - 15	16	34	59	5	6
36	6	13	18	36	62	5	15
34	7	14	20	41	66	6	5
31	8	15	22	46	72	6	19
27	11	18	26	58	83	8	4
25	13	22	31	70	94	9	14
21	18	28	37	86	111	11	16
18	26	39	49	93	127	13	22
15	37	53	60	106	142	16	14
13	42	60	75	120	167	19	8

A second very important factor affecting development and one closely connected with temperature as well as the other factors, such as humidity and the nature of the breeding medium, is that of fermentation. During the process of fermentation, heat is generated inside the manure heaps. This heat differs with different breeding media. In some of these, the temperature may be favourable and accelerate the rate of development, and in some others, which may be the majority, the temperature is sufficiently high to cause death to any of the early stages of the fly. To test the importance of fermentation to development, several observations have been made on large heaps of horse dung, pig dung, cow dung, donkey dung, human excrement and other decomposing substances, and it has been found that only in cow dung, human excrement and in some decomposing vegetable matter the heat generated was favourable enough (about 30-35° C.) to accelerate the rate of development. But with the other kinds of dung, the case was different. In horse dung the temperature was about 75° C. which is undoubtedly absolutely fatal to flies at any stage of development. In pig dung the temperature recorded was about 68° C. which is also detrimental. Fermenting donkey dung accumulated in stables also generated heat which is strong enough to render the survival of the early stages of the fly impossible. It was generally

found that the fly-breeding capacity of the manure is reduced with progress of fermentation, especially in cow, horse and donkey dung. In pig dung, however, the fly breeding capacity is retained much longer than in other kinds of dung.

A third important factor that has a remarkable influence on development is humidity which also differs according to the breeding media. In a previous paper by the author (Hafez, 1939), it was shown by experiments that horse dung, owing to its loose and coarse nature on one hand and very high temperature in Egypt during the summer of the other hand, dries up quite rapidly and in a few days loses most of its water content. In cow dung and pig dung the drying up takes place more slowly due to the high water content in the dung from the beginning and the considerably thick crust formed on the surface of the dung. Under natural conditions the case may be somewhat different since these different kinds of dung are accumulated in large heaps and thus drying is very slow and favourable humidity is available. In the laboratory several experiments were carried through with the purpose of determining the possible influence of humidity on the rate of development. In two series of experiments carried out, horse dung was utilised as a breeding medium and the temperature was 25-30° C. In the first series the dung was kept moist by adding few drops of water or urine whenever it showed any signs of becoming dry, while in the second series the dung was left to dry up. It was noticed that the larvae reared in the first series completed development in ten days while those of the second series in nineteen days.

Therefore, it is obvious that under similar conditions with regard to temperature the rate of development is proportional to the condition of the breeding medium and food as regards moisture. In some of the experiments it was also noticed that with insufficient moisture the flies emerged were undersized. Considerable lack of humidity proved to be of a very detrimental effect on the larvae.

A fourth factor that undoubtedly plays an important part on the development is the nature of the breeding medium or in other words the character of the larval food. Different kinds of dung or other media differ from each other in several respects such as the chemical and biological composition and that, accordingly, may differently influence the rate of development. Therefore, a series of experiments were carried out to determine the different rates of development with different kinds of food. In one of the experiments, horse dung, pig dung, donkey dung, sheep dung, human excrement and kitchen refuse were utilised, each being placed in a glass vessel with a number of very young larvae. The average temperature was about 27° C., and moisture was rendered available. It was found that the durations of

development were about eight days in pig and horse manures, about ten days in sheep dung, fourteen days in human excrement, and about twenty days in the kitchen refuse. That obviously shows that although these larvae were bred under the same conditions of temperature and nearly same moisture yet they completed development in different durations indicating that they are influenced in different degrees by different breeding media and food conditions.

VI. MORPHOLOGY OF THE EARLY STAGES

1. Egg and hatching mechanism

The egg of *Musca vicina* Macq. (Fig. 1.) is 0.9 to 1.1 millimetre long. The colour is shining white. The shape is nearly oval-cylindrical with a slightly tapering anterior end. The posterior end is somewhat rounded and distinctly broader. The surface of the egg-shell is finely sculptured with minute and very faint hexagonal areas or markings. These are less distinct than those of *Musca domestica* L.. A ventral and dorsal sides corresponding to

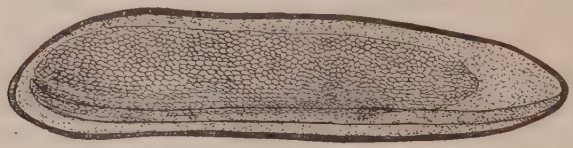


Fig. 1. — Egg of *Musca vicina* Macq. — × 80.

those of the larva can be distinguished ; the ventral side is convex, the dorsal is somewhat concave with a broad but not pronounced and nearly spindle-shaped area bordered by a continuous groove. During the process of hatching the egg-shell splits along the border line of the spindle-shape area at one side only. This begins always at the anterior end and then continues posteriorly, and by this time the first stage larva crawls out.

2. The first stage larva

The larva of *Musca vicina* Macq. just after hatching is as long as the egg (1.1 mm.), but during the first instar a remarkable increase in size and length of the larva takes place as shown by the following measurements :

Length in millimetres : 1.3, 1.5, 2.0, 2.4, 3.0, 3.6.

The shape of the anterior four segments is nearly conical, while that of the rest of the abdomen is cylindrical with the last segment obliquely truncate. The tegument of the living larva is thin and transparent so that

the internal structures such as trachea, alimentary canal and other organs can be easily seen through the skin.

The body segments are apparently twelve in number; a small conical head, followed by three thoracic and eight abdominal segments.

On the ventral surface of each of the eight abdominal segments there is a transverse band of spines situated along the anterior margin of each segment. The spines of the same spiniferous band are of varying size.

There are no anterior spiracles in the first larval stage. Respiration is of the metapneustic type. The spiracles are simple in structure. Each of the longitudinal tracheal trunks dilates posteriorly and opens in the last abdominal segment by a pair of small oblique slit-like apertures situated on a small prominence.

The head is divided into two anterior lobes. There is a small two-segmented antenna or sensory papillae on the dorsal side of each lobe. The distal segment is more slender and partly inserted in a thicker and shorter proximal one. Anterior to the antenna there is another sensory organ, the so-called maxillary palp consisting of about 8 minute tube-like structures lying close to each other.

The area behind the lobes is covered dorsally with minute tubercles. In the ventral surface around the mouth there is an incomplete and nearly circular area traversed by radially arranged grooves or furrows some of which, especially those situated more anteriorly and posteriorly, are slightly shorter than the others. These furrows correspond to the food channels found in other Muscoidean larvae, and serve to distribute the saliva over the surface of the food substances.

The cephalo-pharyngeal skeleton of the first stage larva differs considerably from that of the other stages. Generally, it is much slender and less chitinized. Posteriorly, there is a pair of large pharyngeal sclerites deeply incised behind forming dorsal and ventral cornua or prolongations, the dorsal being shorter and more weakly chitinized. The ventral floor of the pharynx is unchitinized and transparent. The two pharyngeal sclerites are connected dorsally and anteriorly by a small chitinized dorsal arch. The front ventral edges of the pharyngeal sclerites are connected with the anterior sclerites of which the one next to the pharyngeal sclerites is the hypostomal sclerite. This consists of an unpaired median plate. Dorsal, but more anterior to the hypostomal sclerite, there is a rather large median plate which may be called the epistomal sclerite. This is markedly curved from side to side and strongly chitinized at its latero-ventral edges. It is also provided with an anterior and posterior pairs of sensory organs.

Anterior to these sclerites there is the mouth-hook, or the mandibular sclerite, with its tip curved downwards. It is slender and heavily chitinized.

Lying on either side of the mouth-hook there is a small curved plate known as ectostomal sclerite (Thomsen, 1935). Between the ectostomal sclerites, dorsally, is an unpaired rod-shaped sclerite which may be termed according to Lowne (1890-1892) the prestomal sclerite.

3. The second stage larva

The length of the second stage larva of *Musca vicina* Macq. varies between 4.0 and 7.8 millimetres. In general shape this larval stage resembles the first, but however there are some points of difference in detail. The spiniferous bands or locomotory pads are well developed. Respiration is of the amphipneustic type. The prothoracic or anterior spiracles are provided with 5 to 8 finger-like processes. In *Musca domestica* L., according to Hewitt (1914), there are seven of these digitate processes. Each of the posterior spiracles opens by two small orifices similar in shape to those of the first instar but distinctly larger in size. The head of this stage is morphologically very similar to that of the third stage, which will be described later.

Cephalo-pharyngeal skeleton : The pharyngeal sclerites are much like those of the third stage. The hind part of the ventral prolongations are not chitinized. The dorsal arch is now a distinct sclerite provided with irregular perforations or holes giving it a reticular appearance.

The hypostomal sclerite is separate from the pharyngeal sclerites, but still articulates with their ventral cornua. It is now composed of two distinct strongly chitinized plates connected transversely by a narrow bar of chitin and thus giving the H-shape.

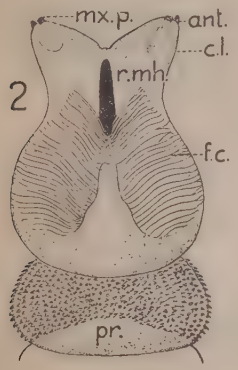
In front of the hypostomal sclerite there is the epistomal sclerite which is now saddle-shaped and heavily chitinized and also provided with the two pairs of sense-organs which are here more distinct than in the previous stage. Anterior to the epistomal sclerite, on each side, there is a small short curved plate named by Thomsen (1935) the accessory stomal sclerite.

In front of these are the paired mandibular sclerites or mouth-hooks which are more chitinized and with slender anterior and thick posterior ends. On either side of the mouth-hook there is the ectostomal sclerite which is here well developed and roughly triangularly shaped.

4. The third stage larva

The third stage larva varies from 8.0 to 13.2 mms in length, sometimes reaching 14 mms. The larva increases remarkably in size during this stage. The head of the full-grown larva (Figs. 2 and 3) displays some important features. It has the mouth situated ventrally in a slight depression. From this oral depression numerous fine furrows of a chitinous nature radiate

and occupy most of the ventral surface of the head. These furrows serve as food-channels in which the food passes to the mouth. The head or cephalic lobes are here very distinct and well pronounced and each is provided with the usual small two-segmented antenna and the so-called maxillary palp made of about 8 sensillae.



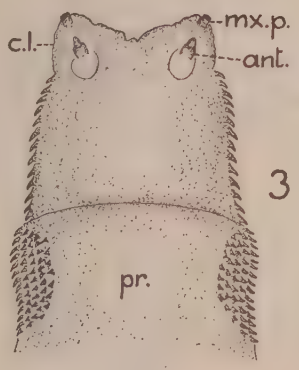
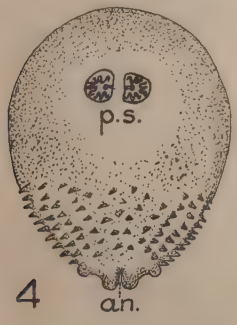


Fig. 2. — Ventral view of head and prothorax of third stage larva : *ant.*, antenna; *c.l.*, cephalic lobe; *f.c.*, food channel; *mx.p.*, maxillary palp; *pr.*, prothorax. — × 170.

Fig. 3. — Dorsal view of head and prothorax of third stage larva : *ant.*, antenna; *c.l.*, cephalic lobe; *mx.p.*, maxillary palp; *pr.*, prothorax. — × 153.

The anterior portion of the prothoracic segment is distinctly demarcated from the head and from the rest of the segment so as to form a sort of collar into which the head can be retracted. It is covered with small spines. The



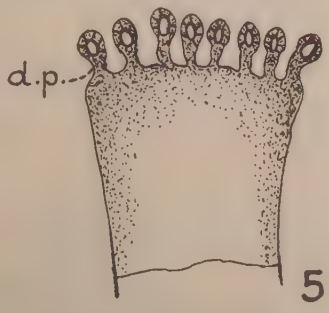


Fig. 4. — Last abdominal segment of third stage larva (back view) : *an.*, anus; *p.s.*, posterior spiracle. — × 46.

Fig. 5. — Anterior spiracle of third stage larva : *d.p.*, digitate process. — Much enlarged.

eight abdominal segments show a remarkable increase in size towards posterior end. The transverse bands of spines on the ventral surface of each segment are here more conspicuous and the spines are more developed. These bands are considered to be locomotory pads by means of which the larva moves forwards and backwards. The last segment (Fig. 4) is richly provided with papillae and thick spines which help in locomotion together with two prominent anal lobes situated ventrally. This segment also bears the anus which is a longitudinal slit.

The prothoracic spiracles (Fig. 5) have five to eight digitate processes. The posterior spiracles (Fig. 6) are very well developed and show a more complicated nature. They are D-shape with the angles rounded and the flat

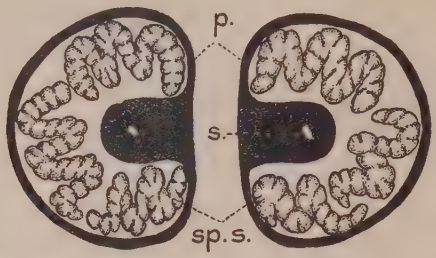


Fig. 6. — Posterior spiracle of third stage larva : *p.*, peritreme; *s.*, scar; *sp.s*, spiracular slit. — × 315.

faces opposing each other. Each spiracle consists of a chitinous ring (peritreme) enclosing three sinuous slits of a characteristic shape, each slit having a row of somewhat irregular denticles along its border forming a sort of a filter. The three slits communicate with the spiracular atrium situated behind the spiracle. Inside the chitinous ring and internal to the flat side there is the scar (cicatrix).

The cephalo-pharyngeal skeleton (Figs. 7 and 8) is composed of several sclerites of which the most anterior are the two mouth-hooks or mandibular sclerites which form the most prominent part of the mouth skeleton. It should be here pointed out that treating with warm caustic poptash (5%) proved very successful in bleaching and clearly demonstrating the mouth-hooks, but when unbleached preparations are examined from the side view the right hook may hide the left one, so that the real condition is not seen and probably is due to such inadequate technique that other previous workers such as Bank (1912) and Hewitt (1914) stated that there was only one unpaired mandibular sclerite or mouth-hook. The two hooks are not equal or identical, the left being smaller and shorter than the right. The anterior part of the left sclerite is distinctly more slender and pointed than

that of the right sclerite. The posterior parts of the two hooks are nearly similar in shape and size. The holes or light spots regarded as sense organ on the internal side of ach mouth-hook is much less distinct than in case of *Musca domestica* L.. The hooks are curved downwards and the right hook

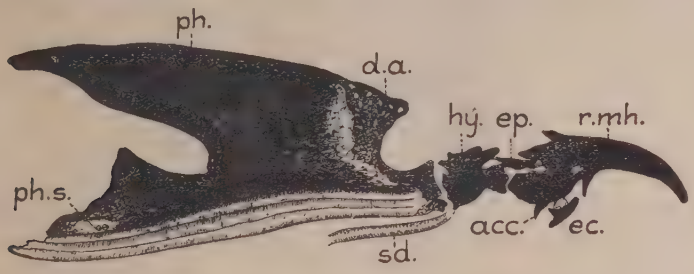


Fig. 7. — Lateral view of the cephalo-pharyngeal skeleton of the third stage larva : *acc.*, accessory sclerite; *d.a.*, dorsal arch; *ec.*, ectostomal sclerite; *ep.*, epistomal sclerite; *hy.*, hypostomal sclerite; *ph.*, pharyngeal sclerite; *ph.s.*, pharyngeal sense organ; *r.mh.*, right mouth hook; *sd.*, salivary duct. — × 120.

is provided with a depression on its ventro-median side. There is, however, some amount of variation in the size and degree of curvature of the two hooks, sometimes the left hook is almost straight.

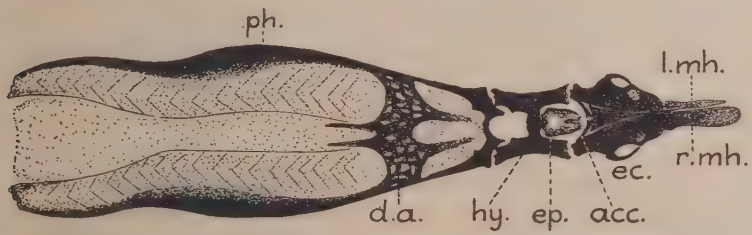


Fig. 8. — Dorsal view of the cephalo-pharyngeal skeleton of the third stage larva : *acc.*, accessory sclerite; *d.a.*, dorsal arch; *ec.*, ectostomal sclerite; *ep.*, epistomal sclerite; *hy.*, hypostomal sclerite; *l.mh.*, left mouth hook; *ph.*, pharyngeal sclerite; *r.mh.*, right mouth hook. — × 125.

Like *Musca domestica* L., there is in between the two mouth-hooks an unpaired median sclerite the presence of which is a remarkable feature described for the first time by Thomsen (1935).

This sclerite consists of a slender anterior part distinctly shorter than the mouth-hooks and a broader posterior part which in some cases seems to be attached or touching the inner sides of the hooks.

Associated with the two mouth-hooks are two pairs of small sclerites,

the largest of which or the ectostomal sclerites of Thomsen (1935) or dentate sclerites of Hewitt (1914) form two curved structures each of which lies on the ventral and lateral side of the corresponding hook. Each ectostomal sclerite begins dorsal with a slender part, curves on the sides and becomes ventral with a slightly broader part below the hook. The other pair of sclerites—the accessary sclerites—is smaller than the ectostomal sclerites and is situated ventral to and near the posterior portions of the mouth-hooks. Each accessory sclerite is a slender rod and indistinctly forked at the median end.

Posterior to the mouth-hooks and more distinctly seen from the dorsal view is a single epistomal sclerite which is somewhat smaller in size and more slender than that of *Musca domestica* L.. It is elongate and curved from side to side. For the most part the sclerite is weakly chitinized, only the sides which bend ventrally and end in a serrated edge are strongly chitinized. The sclerite is provided dorsally with two pairs of sense-organs, an anterior and an posterior pair. The anterior sense organs lies nearly at the tip of the sclerite and appears as light spots of simpler nature. The posterior pair is more distinct and in the form of two dark areas enclosed in light rings. They are situated at a short distance from the posterior extremity of the sclerite.

Behind these sclerites there are the hypostomal sclerites. They consist of two irregularly shaped lateral portions united by a ventral bar of chitin. Each sclerite is longer than broad with its body produced into small angular processes. Below these sclerites posteriorly the two salivary ducts unite.

Next to the hypostomal sclerites there are the two large pharyngeal sclerites. They are narrower anteriorly and broader posteriorly, where they are deeply incised thus producing dorsal and ventral cornua or prolongations. The dorsal cornua are more slender with a convex upper edge, the ventral cornua are broader with a nearly straight lower edge, but the upper margin or edge of each of the ventral cornua is produced into a somewhat angular process which is a very conspicuous character. The whole body of the sclerite except the lower edge is very strongly chitinized and is nearly black in colour.

The pharyngeal sclerites are connected anteriorly by a perforated dorsal plate—the dorsal arch—which can be easily seen in bleached preparations, otherwise it looks as uniform black structure. It may be stated that the light spots are not real perforations but closed by a thin transparant chitinous membrane (Thomsen, 1935).

Ventrally, the pharyngeal sclerites are continuous with the floor of the pharynx, and at the posterior end of the ventral cornua there are the pharyngeal sense organs which are more distinct in unbleached preparations.

5. The puparium

The puparium (Fig. 9), or pupal case, is nearly cylindrical in shape with a slightly tapering anterior end and a distinctly broader and rounded posterior end. It varies in length from 6.0 to 8.2 mms.. but the average length is about 7.0 mms. In *Musca domestica* L., according to Hewitt,

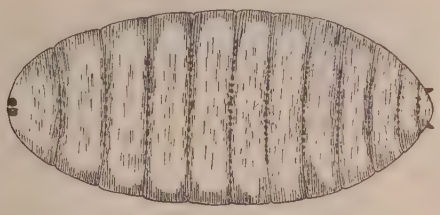


Fig. 9. — Puparium of *Musca vicina* Macq. — × 9.

it is 6.3 mms. The colour immediately after pupation is pale yellow and gradually darkens and finally becomes dark reddish-brown. The pupal spiracles or the anterior spiracles of the larva now appear as minute processes situated anteriorly. The posterior spiracles form two flat button-like structures on the posterior end.

The borders between the segments appear as dotted lines which are very distinct along the middle region of the puparium. The surface of the cuticle is marked with incomplete delicate transverse wrinklings or striations.

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Contribution à la connaissance des espèces égyptiennes du genre *Palarus* Latr.

[Hymenoptera : Sphegidae]

par le Dr. A. Honoré

Faire revivre, dans le cadre de la Faune Egyptienne, un genre dont les espèces étaient, pour la plupart, reléguées dans le fâcheux no mans' land des « species ignotae vel minus cognitae », voilà le but que je me suis proposé en écrivant les lignes qui vont suivre.

F. F. Kohl avait publié, en 1884, son mémoire « *Die Gattugen und Arten des Larriden Aut.* ». Sous sa modeste apparence, ce travail totalisait un ensemble de recherches et d'études considérable ; quelques genres tels que *Miscophus*, *Tachytes* et *Tachysphex* y sont traités avec une rare maîtrise ; d'autres, et parmi ceux-ci le genre *Palarus*, sont d'une indigence manifeste.

L'auteur n'en est réellement pas responsable : la faute en est bien plutôt aux lacunes que devaient présenter les collections dont il disposait. Elles devaient être bien pauvres, ces collections, en ce qui concernait la faune d'Egypte ! Quand on songe que Kohl, dans ce même travail, dit ne pas avoir eu sous les yeux le mâle de *Liris haemorrhoidalis* Fab. ; il ne l'a connu que bien plus tard par l'examen des chasses en Egypte du Rév. F. D. Morice. Ce dernier s'extasie, en 1900 (1), sur ce qu'il a pris en deux jours, entre le Marg et le Caire, plus de *Nectanebus Fischeri* Spin. et de *Masaris vespiformis* Fab., qu'il n'y en avait à cette époque dans tous les grands Musées d'Europe réunis !

Au cours de chasses plus ou moins assidues aux environs du Caire, chasses se répartissant sur une quinzaine d'années, et allant du premier printemps au début de l'été, j'ai pu rassembler assez de matériaux pour me per-

(1) F.D. Morice (*The Entomologist's Monthly Magazine*, 1900, p. 164).

mettre d'identifier les espèces décrites par Spinola, Klug et autres, avec, le cas échéant, les deux sexes appariés sans hésitation possible.

Genre PALARUS Latr., 1802

Caractères du genre :

Mandibules échancrées à leur bord inférieur. Yeux gros, entiers, atteignant en dessous la base des mandibules, plus ou moins convergents vers le haut de la tête ; ocelle antérieur globuleux ; ocelles postérieurs, dans les espèces d'Egypte, aplatis, allongés.

Ailes antérieures : cellule radiale largement tronquée, avec l'indication d'une cellule appendiculaire ; trois cellules cubitales, la deuxième d'allure triangulaire, presque pétiolée, la troisième plus large sur son bord radial que sur son bord cubital.

Ailes postérieures : nervure cubitale sortant de la nervure médiane en dehors de la cellule sous-médiane qui est très allongée.

Segment médiaire court, abrupt, sa face supérieure fortement sillonée en travers, creusée d'une gouttière médiane et de deux sillons latéraux plus ou moins marqués.

Premier segment abdominal (apparent) creusé sur sa face antérieure, et plus ou moins fortement caréné sur les côtés ; à partir du troisième segment, les tergites sont plus développés que les sternites, leur jonction se faisant nettement sur la face ventrale, sous forme de bourrelets carénés. Le deuxième sternite porte généralement une carène transversale épaisse, saillante et de formes diverses. Tous ces caractères s'atténuent plus ou moins chez les petites espèces, et s'effacent complètement chez *Palarus eximius* nov. spec.

Aire pygidiale présente chez les deux sexes ; chez les femelles, en forme de triangle étroit, très allongé ; chez les mâles, de forme très variable suivant les espèces, généralement fourchue ou tri-épineuse.

Pattes robustes, fortement épineuses ; peigne tarsal présent dans les deux sexes, aux pattes antérieures. Hanches intermédiaires assez largement séparées ; les tibias intermédiaires n'ont qu'un seul éperon.

Distinction des sexes. — En dehors du nombre d'articles des antennes (♂ 13, ♀ 12 articles), les mâles à antennes longues ont les articles intermédiaires dilatés. Ce qui, dans nos espèces, permet de distinguer les mâles à première vue, c'est la forme de l'aire pygidiale (dernier tergite visible), qui peut être fourchue, ou tri-épineuse, ou coupée carrément avec ou sans épines latérales ; chez les femelles, l'aire pygidiale est très allongée et à pointe aiguë.

Coloration. — Les grandes espèces sont de coloration foncière d'un jaune plus ou moins foncé, avec le thorax noir en grande partie ; les petites espèces sont noires (ou rougeâtres) avec des bandes de couleur claire tran-

chant sur le fond. *Palarus ambustus* est d'un brun-noir. D'après les matériaux à ma disposition, la coloration est assez constante.

Position systématique et affinités :

Le genre *Palarus* a été créé par Latreille en 1802 (Hist. Crust. et Ins., III, p. 336). Il n'y a eu dans la nomenclature qu'un seul synonyme, *Gonius* Panz., 1806, lequel *Gonius* était plutôt une création de Jurine dont la Nouvelle Méthode n'a paru qu'en 1807 ; quel qu'en soit le véritable auteur, *Gonius* a disparu par la suite, il n'en a plus jamais été question.

Cette simplicité dans la synonymie, le genre *Palarus* la doit surtout au fait que pendant très longtemps on n'a réellement connu qu'une espèce, *Palarus flavipes* Fab., d'Europe, les quelques espèces exotiques décrites par Fabricius et Latreille étant méconnaissables.

A vrai dire, le genre *Palarus*, considéré dans son ensemble, n'est pas très homogène ; il est bien défini tant qu'il s'agit des espèces des régions Paléarctique Occidentale et Nord-Africaine, et c'est dans ce cadre qu'il faut prendre les caractéristiques données ci-dessus.

En dehors de ces limites faunistiques, on voit apparaître des modifications qui peuvent avoir une très grande importance. Ainsi, chez des espèces orientales les yeux ne sont plus convergents en dessus de la tête, l'espace qui les sépare augmente sensiblement, les ocelles postérieurs ne sont plus allongés et aplatis, mais deviennent globuleux et arrondis comme l'ocelle antérieur. Or, cette forme allongée et aplatie (dite aussi en forme de virgule) des ocelles postérieurs est un caractère de première importance qui, dans la classification des Sphégides, détermine non pas un genre, mais des groupes de genres !

Les *Palarus* ont été rapprochés des *Nysson*, des *Cerceris*, des *Philanthus*, même des *Oxybelus*, et cette opinion était encore la moins déraisonnable. La vraie place du genre *Palarus* est dans le groupe de genres gravitant autour des genres *Larra* et *Tachysphex*.

Kohl, dans son « *Groupement naturel des Sphégides* » paru en 1896, assigne au genre *Palarus* une place annexe dans son quatrième groupe : *Larra* Fab.. Les affinités du genre avec l'ensemble du groupe sont indéniables, et il n'y a guère moyen de le mettre ailleurs. Il y a bien, de par la constitution spéciale des arceaux abdominaux, quelques rapports avec le genre *Oxybelus*, mais la parenté s'arrête là.

Kohl (loc. cit.), a imaginé de partager les Sphégides en un certain nombre de « Groupes de Genres » (Gattungsgruppe), comprenant chacun plusieurs noyaux ou sous-groupes, autour desquels viennent se ranger les genres plus ou moins aberrants.

Cette conception, étant donnée l'extraordinaire complication des caractères génériques chez les Sphégides, est bien préférable à celle consistant à

scinder cette grande famille naturelle en un certain nombre de familles et de sous-familles, car, avec le grand nombre de genres restant isolés, il faudrait multiplier les sous-familles à l'infini ou leur donner des caractères tellement flous qu'il n'y aurait plus aucune division bien délimitée.

Kohl avait bien compris le fait après la publication du travail auquel j'ai fait allusion au début (*Die Gattungen und Arten des Larriden Aut.*) ; il y avait fait entrer, à côté du genre du Groupe *Larra* actuel, les genres suivants : *Pison* Spin., *Trypoxylon* Latr., *Nitela* Latr., *Solierella* Spin., *Miscophus* Jurine et *Astata* Latr.. On voit d'ici le résultat : aucun caractère ne s'appliquait en même temps à tous les genres et cependant tous ces genres « se tiennent » !

Le genre *Palarus* n'est pas très riche en espèces ; Kohl, en 1896, en comptait une vingtaine, toutes de l'ancien monde, dont 7 ou 8 habitaient l'Europe, le nord de l'Afrique et l'Asie Occidentale ; de ces mêmes régions, on a décrit depuis encore 4 ou 5 espèces, soit une douzaine en tout.

D'Egypte, on connaissait *histrio* Spin., *ambustus*, *laetus* et *lepidus*, tous trois de Klug, *Spinolae* Saussure et *Saundersi* Morice. J'ai retrouvé ces espèces, sauf *lepidus* (et encore peut-être ?) ; je puis y ajouter deux nouvelles espèces, *decipiens* nov. spec. et *eximius* nov. spec.. Les mâles de *Spinolae* et de *laetus* sont assez communs dans les zones cultivées, les femelles de ces deux espèces sont beaucoup moins communes ; quant aux autres elles se trouvent plutôt en bordure du désert et paraissent devoir être rares.

Mœurs :

Pendant longtemps, les mœurs des *Palarus* ont été peu connues. Les individus n'abondent pas comme les *Cerceris* et le *Philanthus ;* les femelles sont généralement très farouches et sont difficiles à observer d'assez près.

Palarus flavipes Fab. capture toutes sortes d'hyménoptères, même des plus robustes (2) ; *histrio* Spin. et *humeralis* Duf. ont été observés par Ferton en Algérie (3) : le premier capturerait principalement des Scolies et des *Polistes*, le second s'en prendrait surtout aux *Halictus* de taille moyenne ou petite, aussi bien mâles que femelles. Le nid est creusé peu profondément dans le sable dur.

Palarus histrio n'existe pas autour de Hawamdieh ; par contre *laetus* y est commun certaines années, et j'ai pu le voir capturer des mâles de *Cerceris subimpressa* Schlett. et de *Cerceris Fischeri* Spin.

J'ai pu assister une fois, à Hawamdieh, à un combat qui devait être

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(2) Dufour (*Ann. Soc. Entom. France*, 1841, p. 354).

(3) Ferton : Notes détachées, 7e série (*Ann. Soc. Entom. France*, 1911, p. 365).

bien farouche entre une femelle de *Palarus Spinolae* et un *Stizus* jaune d'assez grande taille, qui malgré son énergique défense, fut maîtrisé et emporté au vol.

Tables pour la détermination des espèces du Genre *Palarus* en Egypte

♂♂

1. Aire pygidiale très allongée, à côtés paralèlles, coupée carrément et légèrement échancrée à l'extrémité ..... *Saundersi* Morice

—. Aire pygidiale autrement conformée 2

2. Aire pygidiale allongée, profondément incisée au milieu. Antennes non claviformes, ayant au moins quelques articles dilatés en dessous. Longueur 14 à 17 mm. 3

—. Aire pygidiale courte et large, tridentée à son bord postérieur. Antennes courtes, claviformes. Longueur 12 mm. maximum 4

3. Les deux lobes de l'aire pygidiale sont divergents. Articles 3 à 12 des antennes dentés en dessous. Métatarse I normal ..... *Spinolae* Sauss.

—. Les deux lobes de l'aire pygidiale sont paralèlles. Articles 9 à 11 des antennes renflés en dessous. Métatarse I fortement élargi, le bord postérieur portant des soies spatuliformes ..... *decipiens* nov. spec.

4. Coloration d'un brun foncé, éclaircie par places. Ponctuation de l'abdomen forte et serrée, donnant un aspect mat. Longueur 7-8 mm. .... *ambustus* Klug

—. Coloration noire (ou en partie rouge) avec des bandes d'un blanc-jaunâtre en accent circonflexe, sur l'abdomen. Ponctuation moins forte 5

5. Le deuxième sternite porte un callus transversal plus ou moins élevé, occupant toute la largeur du segment ; les sternites suivants portant un bourrelet incisé au milieu. Longueur 10-11 mm. 6

—. Face ventrale de l'abdomen lisse, sans callus au deuxième sternite, ni bourrelets bien marqués. Longueur 5.5 mm. ..... *eximius* nov. spec.

6. Plus robuste, la largeur de l'abdomen égale les trois-dixièmes de la longueur totale ; bandes claires de l'abdomen faisant nettement saillie sur la surface des tergites. Yeux plus écartés que la longueur du deuxième article des antennes ..... *histrio* Spin.

—. Plus grêle, la largeur de l'abdomen égale les deux-dixièmes de la lon-

gueur totale ; bandes jaunâtres de l'abdomen plus aplaties, ne se détachant pas de la surface des tergites. Yeux moins écartés que la longueur du deuxième article des antennes ..... *laetus* Klug

♀♀

1. Couleur foncière de l'abdomen jaune ochracé. Longueur 14 mm. au moins 2

—. Couleur foncière de l'abdomen noire ou rougeâtre, avec des bandes d'un blanc-jaunâtre. Longueur 12 mm. au plus 4

2. Antennes noires à l'extrémité. Ailes jaunâtres, avec une tache grise dans leur tiers extérieur. Plus robuste, largeur de l'abdomen égalant les quatre dix-septièmes de la longueur totale ..... *Spinolae* Sauss.

—. Antennes entièrement orangées. Ailes complètement hyalines. Plus élancé, largeur de l'abdomen égalant les trois-quatorzièmes de la longueur totale ..... *decipiens* nov. spec.

3. Deuxième sternite boursouflé de chaque côté, avec un sillon entre les deux protubérances. Plus large ..... *histrio* Spin.

—. Deuxième sternite lisse, son bord postérieur très légèrement échancré. Plus étroit ..... *laetus* Klug

Manquent dans cette table les femelles de *Saundersi* Morice, *ambustus* Klug et *eximius* nov. spec. qui ne sont pas connues.

Les *Palarus* se partagent en deux groupes, suivant la forme de l'aire pygidiale chez les mâles.

Le premier groupe comprend les espèces chez lesquelles l'aire pygidiale, plus longue que large dans son ensemble, est plus ou moins profondément incisée en son milieu, l'incision pouvant être réduite à une légère échancrure (*Palarus Saundersi* Morice).

Les espèces sont généralement de taille avantageuse, dépassant 13 millimètres ; de coloration allant du jaune franc à l'ocre clair.

Le type du groupe serait *Palarus flavipes* Fab. d'Europe, qui est en même temps le type du genre ; dans ce groupe viennent se ranger *Palarus Spinolae* Sauss., *Saundersi* Morice et *decipiens* nov. spec.

Dans le second groupe, l'aire pygidiale, plus large que longue dans son ensemble, est tridentée à son bord postérieur, la dent médiane étant plus longue que les dents latérales, dont le développement est variable.

La taille est plus faible, longueur de 6 à 12 millimètres.

La coloration foncière est généralement noire, pouvant passer au rouge,

avec des bandes claires sur l'abdomen ; *Palarus ambustus* Klug, de couleur d'un brun foncé, fait exception.

Palarus Spinolae Saussure, 1854. (Mélanges Hyménoptérologiques, Fasc. I, in *Mém. Soc. Phys. Sc. Nat. Genève*, p. 14).

Le plus puissant de nos *Palarus:* mâle, 14 à 17 mm., femelle 22 mm. de longueur et plus.

Coloration générale ocracée en dessus, devenant très foncée en dessous ; la pointe des mandibules et le vertex sont rembrunis. Le thorax est noir, avec le pronotum, le scutellum et le post-scutellum jaunes ou ocres ; le segment médiaire et la concavité antérieure du premier segment de l'abdomen sont également noirs. Les jointures des segments abdominaux sont très rembrunies, affectant même l'apparence de minces bandes noirâtres légèrement dilatées en triangle au milieu.

Antennes rougeâtres, les deux derniers articles noirs. Pattes jaunes ou rousses. Ailes jaune clair, avec une bande grisaille dans leur tiers extérieur.

Les mâles sont généralement d'un jaune plus clair que les femelles, mais il s'en trouve aussi chez lesquels au contraire le noir envahit le thorax, avec l'abdomen fortement rembruni.

♀.—Le deuxième sternite présente un tubercule conique élevé, tronqué et excavé au sommet, le bord antérieur de la troncature tranchant, le bord postérieur presqu'effacé.

♂.— Articles 4 à 11 des antennes renflés-denticulés en dessous. Le premier sternite offre un petit callus aplati bi-épineux ; le deuxième présente une grande saillie transversale, bombée en arc de cercle régulièrement arrondi, creusée sur sa tranche d'une gouttière dont les bords avant et arrière sont très saillants.

Les bords latéraux du sixième sternite sont relevés en carène, le septième est terminé par un cône aigu, allongé.

Aire pygidiale à lobes divergents, laissant voir en dessous la pointe noire qui termine le septième sternite. Pas de touffe de poils sur les côtés.

Assez commun à Hawamdieh (17♂♂, 4 ♀♀), de la mi-Mai à fin Juin, surtout sur les inflorescences de poireaux.

Palarus decipiens nov. spec.

La femelle ressemble beaucoup à celle de *Palarus Spinolae* Sauss. ; le mâle est voisin de celui de *humeralis* Dufour, 1853, redécrit par Kohl en 1884, pour lequel je l'avais pris au début.

♀.—Facies de *Palarus Spinolae* Sauss., mais s'en distingue facilement. Coloration d'un jaune franc dessus et dessous ; mésothorax noir en dessus

seulement, ainsi que le segment médiaire dessus et sur les côtés ; la concavité antérieure du premier segment abdominal rembrunie. Abdomen entièrement jaune, sans traces de bandes foncées aux jointures des segments. Antennes entièrement rousses. Pattes jaunes-roussâtres. Ailes complètement hyalines.

Moins grand et moins robustes que *Palarus Spinolae* Sauss., longueur 14 mm. Ponctuation du mésothorax plus espacée. Le tubercule du deuxième sternite est moins net.

♂.— Coloration comme chez la femelle, plus ocracée. Ailes légèrement jaunâtres, mais sans tache grise.

Antennes à articles à 4 à 8 peu renflés en dessous, 9 et 10 nettement élargis, 11 et 12 le sont aussi, mais moins.

Métatarse des pattes antérieures élargi comme chez *Palarus humeralis* Dufour (Kohl), à bord postérieur festonné et garni de poils spatuliformes très blancs, les articles suivants garnis de longs cils blancs flexibles, et en dessous, de petites touffes de poils noirs, courts.

Premier sternite avec un petit callus bi-épineux. Deuxième sternite offrant une saillie pareille à celle du mâle de *Palarus Spinolae* Sauss., mais dont la bordure postérieure de la gouttière n'est pas régulièrement arrondie comme l'antérieure : vue de profil arrière, elle figure une ligne anguleuse par suite de la présence de quatre dents dont les deux médianes sont les plus fortes et les deux latérales à peine marquées. Le troisième sternite porte une carène transversale tranchante, peu élevée ; dans sa description de *Palarus humeralis* ♂, Kohl ne fait pas mention d'une pareille carène.

♂ et ♀ types pris ensemble à Sokhna (littoral de la Mer Rouge), au début de Juillet ; je possède encore un autre individu mâle du même endroit.

Palarus Saundersi Morice, 1897.

Décrit de Koubbeh, 4.4.1896, sur un exemplaire mâle.

♂.— Coloration semblable à celle de *Palarus Spinolae* Sauss. sauf en ce qui concerne les antennes qui sont noires, et les ailes à peine jaunâtres, sans tache grisaille. Longueur 12 mm. (Morice indique pour son exemplaire 15 mm.).

Très distinct des autres espèces par son aire pygidiale. Celle-ci est allongée, très étroite dans sa moitié antérieure, un peu élargie dans sa moitié postérieure, la surface est creusée, lisse, brillante ; le bord terminal n'est pas incisé, mais seulement très légèrement échancré.

Callus du deuxième sternite comme chez *Palarus decipiens* nov. spec., seulement le bord antérieur n'est pas caréniforme et le bord postérieur est multidenté. Il n'y a pas de carène transversale sur le troisième sternite.

♀.— Inconnue.

Un seul mâle, Abou-Roasch, fin Mai.

Palarus ambustus Klug, 1843.

Décrit de Sakkarah.

♂.—Facile à distinguer parmi les espèces à aire pygidiale tridentée. Coloration d'un brun foncé, avec des taches testacées plus ou moins développées sur les segments dorsaux de l'abdomen. Une tache jaune clair aux angles antérieurs du mésothorax devant les écailles alaires qui sont également jaunes ; ces deux taches se retrouvent chez tous les cinq exemplaires examinés. Pattes jaunes roussâtres, les fémurs rembrunis. Antennes rembrunies en dessous, plus claires en dessus, les premiers articles noirs. Ailes hyalines.

Ponctuation générale serrée, surtout sur l'abdomen, donnant à celui-ci un aspect mat caractéristique.

Deuxième sternite muni d'un tubercule en carène transversale.

Aire pygidiale développée en une plaque plus large que ne l'est le tergite précédent ; la dent médiane est assez longue, les dents latérales sont fortes, élargies.

♀.—Inconnue.

Trouvé une fois à Kerdacé 5 mâles, au début de Mars, dans une culture de Lupin abandonnée.

Palarus histrio Spin., 1838.

♂.—Coloration noire, devenant rougeâtre sur le dessus des segments abdominaux, d'un brun plus ou moins foncé sur le dessous du corps. Mandibules, clypeus, bord interne des yeux, une ligne inter-antennaire, le bord du pronotum, les écaillettes, deux taches devant et en-dessous de celles-ci, le postscutellum, jaunes. Sur l'abdomen, des bandes jaunâtres, arquées, devenant angulaires sur les derniers segments. Plaque pygidiale jaune. Antennes jaunâtres en dessus, noirâtres en dessous, les premiers articles noirs. Pattes d'un jaune roux, les fémurs tachés de noir. Longueur 11 mms.

Premier sternite avec une petite gibbosité incisée au milieu. Deuxième sternite avec un bourrelet très développé, en arc de cercle, à bord postérieur tranchant.

♀.—Coloration et distribution des bandes et taches coloriées comme chez le mâle, sauf en ce que la coloration foncière de l'abdomen en dessus qui est entièrement rouge. Ailes légèrement jaunâtres. Longueur 12 mm.

Le deuxième sternite ne porte pas de protubérance bien marquée, seulement deux légères callosités, séparées par un sillon médian ; ces callosités, légèrement ponctuées sur leur surface, portent sur leur face arrière, deux « miroirs », sous forme de dépressions légères, polies, de couleur noire.

Je n'ai jamais trouvé que deux exemplaires, un de chaque sexe, à Sakkarah, au début de Mai.

Les colorations données ci-dessus diffèrent légèrement de celles données

par Spinola; il y a certainement une certaine variabilité dans le développement de la coloration rouge. Le tout constitue un curieux bariolage, qui explique bien le nom de *histrio* appliqué par Spinola. Je signalerais qu'il y a une bonne figure coloriée de cette espèce dans « Lucas, *Exploration scientifique de l'Algérie*, 1849, planche XII, fig. 7 [♀] de l'Atlas des Hyménoptères.

Palarus lepidus Klug, 1843 (?).

Je possédais depuis longtemps un exemplaire femelle de *Palarus* pris à Dahschour, fin Mai 1931, que j'avais, sans grande confiance, attribué à *histrio* Spin.. La connaissance du véritable *histrio* Spin., et la comparaison avec une grande série de *laetus* Klug (cf. infra), m'ont amené à considérer cet insecte comme étant *lepidus* Klug ♀.

D'abord, sauf quelques détails, de très minime importance dans la coloration, l'exemplaire correspond bien à la description de Klug.

Ensuite, Klug dit : « Spinola Palari speciem huic affinem nomine *P. histrio* proposuit. Feminae descriptio autem, quamvis in multis, non tamen omnino nostrae convenit..., etc. ». Précisément, l'insecte en question ressemble étonnement à *histrio* Spin., mais en est certainement différent.

Un caractère décisif est l'écartement moindre des yeux sur le vertex, écartement réduit de moitié par rapport à *histrio* Spin.; ensuite, l'aire pygidiale est plus large dans son ensemble et moins aiguë à la pointe; la ponctuation est plus serrée et donne à l'insecte un aspect plus mat; enfin le deuxième sternite n'a pas les callosités décrites à propos de *histrio* Spin., la surface du sternite est plane, à peine ponctuée, son bord postérieur échancré au milieu en un angle très ouvert.

Donc cet insecte n'est pas *histrio* Spin.; il n'est pas non plus *laetus* Klug puisque cet auteur dit de son *laetus* : « Precedenti (*P. lepidus*) proximus, differt praesertim quoad formam corpore graciliore... ». En effet, *laetus* Klug, assez commun à Hawamdieh, est beaucoup plus grêle que *histrio* Spin., et *lepidus* Klug doit avoir le facies de *histrio* Spin.

Si l'individu en question ne se rapportait pas à *lepidus* Klug, il faudrait le considérer comme une espèce non décrite; il n'est pas recommandable de décrire un *Palarus* femelle sans en connaître le mâle; je préfère m'en tenir aux conclusions ci-dessus : le considérer comme étant *lepidus* Klug ♀.

Palarus laetus Klug, 1843.

Décrit de Sakkarah et des Pyramides.

♂.—Facies de *histrio* Spin., mais plus grêle et un peu plus petit.

Coloration générale noire devenant plus ou moins rouge sur l'abdomen. Clypeus, côtés du pronotum, angles antérieurs du mésothorax, écaillettes et

différentes taches en dessous de celles-ci, scutellum et post-scutellum ou seulement l'un des deux, taches symétriques, de développement variable, sur les angles et les côtés du segment médiaire, jaunâtres. Sur le dos de l'abdomen, les bandes colorées sont d'un jaune plus intense et sur des bourrelets moins prononcés que chez *histrio* Spin. La plaque pygidiale est jaune ou noire. Antennes d'un brun-jaune sale. Pattes jaunes avec les fémurs et aussi les tibias tachés de noir. Ailes hyalines.

Deuxième sternite avec un callus transversal à arête postérieure tranchante ; le troisième sternite porte les rudiments latéraux d'une carène interrompue au milieu.

Plaque pygidiale plus étroite que le sixième tergite, les dents latérales peu marquées.

♀.—Coloration foncière, taches et bandes colorées comme chez le mâle. Antennes plus claires. Pattes jaunes avec les fémurs tachés de brun-clair. Ailes très légèrement jaunâtres sur le disque.

Deuxième sternite lisse, sans aucune protubérance, le bord postérieur échancré.

Assez commun à Hawamdieh (20 ♂♂ et 14 ♀♀), en Mai-Juin.

Klug (loc. cit.) a commis une erreur en supposant que le mâle de *Palarus histrio* Spin. n'appartenait pas à cette espèce mais à *Palarus laetus* Klug, et Kohl, qui ne connaissait de visu aucune des espèces en question, avait trouvé plus simple de mettre *Palarus laetus* Klug ♂ et ♀ en synonymie de *Palarus histrio* Spin. Les deux espèces sont bien distinctes.

Palarus eximius nov. spec.

Curieuse petite espèce, sortant déjà du genre *Palarus*, tel qu'il a été défini plus haut.

Ressemble quelque peu à un très petit *Palarus laetus* Klug. Longueur 5.5 mm.

Noir. La coloration, d'un blanc-jaunâtre, est réduite : le bord inférieur du clypeus, deux petites taches aux angles du pronotum, les écaillettes, le post-scutellum et quatre bandes sur l'abdomen sont jaunâtres ; les pattes sont jaunes avec les fémurs noirs. Antennes d'un brun-roux foncé. Ailes hyalines.

Antennes à deuxième article court et large, le troisième nettement plus étroit que le deuxième et égalant presque deux fois la longueur de celui-ci. Chez *laetus* Klug, les différences dans les proportions de ces deux articles sont beaucoup moins grandes. Aux ailes antérieures, la première nervure récurrente aboutit dans la première cellule cubitale et non dans la deuxième.

La déclivité antérieure du premier segment de l'abdomen n'est pas concave, les carènes latérales de cette déclivité sont réduites à une petite dent.

Les bandes jaunes de l'abdomen sont tout à fait à plat sur les téguments,

les bourrelets plus ou moins prononcés que l'on observe chez *laetus* Klug et *histrio* Spin. ont disparu.

Sternites abdominaux sans aucune callosité, aplanis latéralement, et se raccordant normalement avec les tergites, sans présenter les petits reliefs caractéristiques.

Plaque pygidiale à dent médiane longue, les latérales très réduites.

Type : un mâle, Hawamdieh, 12.9.1933, dans une bande de terrain inculte, sablonneux, près du Nil.

Palarus rufipes Ol. (Latr.) ?.

Spinola, en 1838, décrit sous ce nom un mâle de *Palarus* assez énigmatique. La description s'accorde assez bien avec celle de *Palarus decipiens* mihi, mais Spinola ne fait aucune mention de la forme toute spéciale du métatarse des pattes antérieures, caractère qu'il n'aurait pas pu ne pas remarquer.

Il doit s'agir d'une autre espèce, ou peut-être, d'une coloration spéciale de *Palarus Spinolae* Sauss.

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A Note on the Breeding and Movements of the Desert Locust, *Schistocerca gregaria* Forskal, in Egypt during 1941

[Orthoptera : Acrididae]

by Mohamed Hussein,
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I. Previous Recent Invasion

The last great invasion of the Desert Locust on this country, from the East and South-East started in 1927, reached its climax in 1930 and came to an end two years later.

In the spring of 1937 many of the northern regions in the Lybian desert faced a minor attack.

Schistocerca hoppers appeared in barley fields and fig plantations near the Mediterranean coast as well as in patches green with desert shrubs to the North of Kattara depression (lat. 30° 20', long. 27° 5').

II. The 1941 Invasion

Since then no alarming news were received until February 1941, when the Sudan Government reported the breeding of this species at Tokar near the Red Sea.

It seems that favourable climatic conditions, which prevailed there during the previous autumn, played an important role in the propagation of solitary *Schistocerca* living in those localities, and the transformation of their progeny into the congregans and migratory types.

Precautionary steps were immediately taken in Egypt.

Late in March a sample of locusts found in a wadi (path of torrents in the desert), 50 miles East of Asswan (lat. 20° 18', long. 33° 52'), was identified as adults of solitary *Schistocerca*.

During April and early May the part of the South-Eastern Desert from Asswan to Shelatin (lat. 33° 7', long. 35° 37') was scouted.

The Desert Locust was found in varying numbers in many wadies between Asswan and Abrag (lat. 23° 22', long. 34° 44'), Wadi-Hamamid (lat. 24° 10', long. 34° 31'), and Kom-Ombo (lat. 24° 28', long. 32° 55').

Dense locust population was however confined to two areas namely Wadi El Kharit (lat. 24° 15', long. 33° 30' to 34° 25') and part of Wadi Garrara (lat. 23° 45' to 24° 10', long. 33° 45' to 34° 5') where desert plants were profuse and more than 20 locusts were found on each plant.

The rest of this district was less infested and the desert region from Abrag to Shelatin near the Red Sea, and thence to Kosseir, harboured no *Schistocerca*. The scanty vegetation in this region indicated the absence of rain for more than one season rendering it unsuitable for locust propagation.

Locusts were found in fairly large numbers only in the wadies bounded on either side by a continuous chain of rocky hillets; rains falling on the slopes soon collect in the sandy bottom and the wadies become green with vegetation.

In the rest of the infested zone, on the other hand, such elevations are far between and plant life depends more or less upon rain falling directly on the plain.

Again there seems to be a strong correlation between locust population and the kind of plant whether annual or perennial, also on the density of growth. In patches green with annual tiny plants, such as *Aristida*, locusts were found in fewer numbers than in localities rich in perennial and full grown desert shrubs like *Zilla*, *Lycium*, *Artemisia* and *Schouwia arabica* (Vahl.).

III. Origin of the present Schistocerca outbreak

The actual *Schistocerca* outbreak lies somewhere outside Egypt, in the Sudan or Arabia.

Nothing supports the assumption of local breeding among solitary Desert Locusts inhabiting our regions and their transformation into gregarious. No rain had fallen there for six years previous to 1941, and when inspected in 1937 and 1938 no *Schistocerca* in numbers whatever limited were met with.

In the Sudan and Arabia, on the other hand, conditions were quite favourable for breeding in the autumn of 1940 and the following winter.

Fliers migrating from either region sometime in winter reached the above mentioned regions of Egypt and settled to breed, conditions being ideal after heavy rains.

Judging by the number of the resultant generation, the original swarms must have been small.

Their offspring acquired at the beginning the characteristic features of the solitary type. This may be attributed to their distribution over a wide area where desert plants stood apart giving no chance to the comparatively small number of hoppers to collect and form bands.

Even in the two worst infested zones, namely Wadi El Kharit and Garrara, transformation into congregans and migratory *Schistocerca* was not observed except late after the third and fourth moult or even after the emergence of adults.

The main factors causing these changes were climatic. The hot summer winds had already begun at the time of our visit. Where locust populations were fairly high from the very beginning, their progeny deserted drying plants and took shelter in bands under shrubs still green.

The high temperature and low atmospheric humidity prevailing in those regions made the locusts fretful and restless. Hoppers moved in masses and adults took to wing although for short distances.

Such changes in behaviour were accompanied by others in some of the external features : black markings appeared on the body of the hoppers, fliers assumed the red colour indicating transformation into the congregans and gregarious phases.

IV. Fresh swarms come from the East

The control of locusts at Wadi El Kharit and Garrara came to an end in the first week of June.

But all of a sudden on June 16th, Hurghada (lat. 27° 12', long. 33° 38'), Koseir and other ports near the Red Sea reported the arrival of big fresh swarms from the East.

Two days later they reached not only the desert region East of Asswan but also the cultivated areas of both Kena and Asswan provinces.

A swarm flew as far West as Baris (lat. 24° 35', long. 30° 38'), in Kharga Oasis. Fortunately, the invadors had no chance to remain long. On June 20th, a strong North-Westerly wind carried them off and few days later reports indicated their arrival to the northern provinces in the Sudan.

As previously mentioned, actual observations and information collected from local arabs supported the theory that locusts found breeding in the desert East of Asswan must have come from the Sudan or probably from Arabia.

On the other hand, the swarms reported from Hurghada and other ports on June 16th, 1941, were actually observed coming from the East. Undoubtedly they were the progeny of a generation produced in Arabia.

News received from the Egyptian Legation at Jedda in Hedjaz confirmed this point for locust appeared in great numbers at Taif, Mecca and

Medina. About the middle of June the situation became critical, but soon afterwards the swarms departed westwards in the direction of the Red Sea.

Reports received from other sources indicated the breeding of the Desert Locust in Yemen, Aden, Hadramut, Sudan and Eritrea.

Such new developments, as the Central Locust Bureau of London mentions, are sufficient warning that a new cycle of *Schistocerca* has already started demanding a cooperative and effective system for reconnaissance and control by all countries concerned.

Le brachyptérisme de la Courtilière

[Orthoptera : Gryllotalpidae]

(avec 1 Tableau Hors-Texte)

par Antoine Cassab

L'origine de mes recherches sur le problème gryllotalpien remonte au mois d'Avril 1933. Depuis, chaque année au début de Mars et jusqu'en Octobre 1940, un grand nombre de parcelles de terre ont été bêchées dans tout le pays et les courtilières mises à jour ramassées par milliers. Ces opérations sont suspendues de Novembre à fin Février, époque durant laquelle les courtilières hibernent dans leurs galeries souterraines à une profondeur pouvant atteindre jusqu'à un mètre cinquante. Il est alors fort peu aisé de rechercher ces insectes.

L'étude de l'énorme matériel recueilli au cours de ces huit années, environ 34000 individus adultes, a permis :

(1) De confirmer l'existence en Egypte de deux espèces de courtilières, soit :

(a) *Gryllotalpa gryllotalpa* Linné (=*vulgaris* Latr.) et sa forme brachyptère (=var. *cophta* De Haan).

(b) *Gryllotalpa africana* P. de Bauv. dont la forme brachyptère, découverte en 1938, a été récemment décrite (1).

(2) De fixer la répartition des deux espèces dans les différentes parties du territoire.

Cette question a été traitée par l'auteur dans un précédent article (2).

(3) De déterminer la fréquence des sexes.

Nous avons constaté que les femelles prédominent dans la proportion de cinq à deux.

(4) Enfin, d'établir le pourcentage des individus macroptères et brachyptères.

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(1) Antoine Cassab : Sur une forme brachyptère inédite de *Gryllotalpa africana* P. de Bauv. (*Bulletin de la Société Fouad Ier d'Entomologie*, vol. XXIV, 1940, pp. 181-182).

(2) Antoine Cassab : Les Courtilières de l'Egypte (*Bulletin de la Société Royale Entomologique d'Egypte*, vol. XVIII, 1934, pp. 421-426).

La plus ancienne référence que nous possédons sur l'existence en Egypte de la forme brachyptère de *Gryllotalpa gryllotalpa* L. nous est fournie par J. C. Savigny. Cet auteur en a publié une bonne illustration (fig. 3[2]) dans la « Description de l'Egypte » (Atlas Histoire Naturelle, tome II, 1826, Zoologie : Orthoptères, Planche 3 [dessinée et gravée en 1806-1812]). *Gryllotalpa africana* P. de Bauv. figure également sur la planche (fig. 3[1]). La forme typique (macroptère) de *Gryllotalpa gryllotalpa* L. n'est pas illustrée, première indication qu'à cette époque elle était tout au moins bien moins fréquente que la forme brachyptère figurée par Savigny et décrite bien plus tard, par De Haan, en 1842, sous le nom de variété *cophta*.

Ainsi donc, nous savons définitivement que la forme brachyptère de *Gryllotalpa gryllotalpa* L. existe en Egypte depuis au moins 135 ans, puisque la planche de Savigny date de 1806. Si nous ne possédons aucun renseignement sur sa fréquence à cette époque, nous sommes cependant convaincus quelle y prédominait.

Willcocks et Bahgat (3) ont été les premiers à signaler que la forme brachyptère de *Gryllotalpa gryllotalpa* L. est de beaucoup plus commune aux environs du Caire que la macroptère. Nous avons constaté qu'il en est de même dans toute l'étendue du pays : la forme brachyptère prédomine dans les proportions qui sont indiquées sur le Tableau qui termine cet article.

Depuis Savigny, le système d'irrigation, les méthodes culturales, l'intensité et la diversité des cultures ont subi une évolution considérable, modifiant dans une certaine mesure le climat du pays. Ces divers facteurs sont cependant beaucoup trop récents et n'ont certainement pu altérer la morphologie de nos courtilières. Tout au plus ont-ils contribué à une plus grande propagation et dispersion de ces insectes sur toute l'étendue du territoire, à leur adaptation aux conditions nouvelles sans doute plus favorables que celles d'autrefois.

Notre Tableau confirme bien ce qui précède. En effet, il indique que *Gryllotalpa gryllotalpa* L. et sa forme brachyptère sont actuellement distribués dans toutes les provinces, malgré la nature diverse des terres et le régime hygrométrique du pays.

La forme brachyptère de *Gryllotalpa africana* P. de Bauv. s'annonce en 1938, uniquement dans les provinces de Dakahlieh, Calioubieh et Ghizeh. Il est sans doute prématuré de se prononcer sur la possibilité de la voir prédominer à l'avenir sa forme macroptère.

Cependant, l'étude des pourcentages de notre Tableau révèle un détail

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(3) Willcocks et Bahgat : The Insects and related Pests of Egypt : Insects and Mites Injurious to the Cotton Plant (vol. I, part 2, 1937, page 147 [Royal Agricultural Society, Cairo]).

bien troublant : les individus brachyptères de *Gryllotalpa gryllotalpa* L. et de *Gryllotalpa africana* P. de Bauv. sont en augmentation progressive à partir de 1933 et 1938 respectivement. Comment expliquer cette mutation de la forme macroptère à la forme brachyptère ? Quels sont les divers facteurs susceptibles d'engendrer une altération aussi profonde ?

Willcocks et Bahgat (loc. cit.) estiment que l'Egypte, de par son système d'irrigation pérenne fort développé, constitue un pays éminemment favorable à la courtilière si friande d'humidité. Ils se demandent si la typique *Gryllotalpa gryllotalpa* L. n'est pas en voie de se transformer en forme brachyptère et si, avec le temps, elle ne sera plus qu'une espèce totalement aptère !

Certes, la théorie biologique de l'évolution admet la transformation progressive des espèces à travers les âges. Ainsi, nos deux espèces de courtilières et leur forme brachyptère dérivent incontestablement d'une *seule* forme ancienne *différente* qui existait à une époque géologique antérieure à la nôtre. A quelle époque remontent nos espèces et formes actuelles ? Nul ne saurait le dire ! Nous sommes en présence de l'ancienne forme, actuellement polymorphe. Les auteurs modernes, pour la convenance de l'entomologie systématique, ont assigné à ces formes des noms qui permettent de les distinguer entre elles.

Tenter d'expliquer l'origine et les causes du brachyptérisme de nos courtilières sur la base de théories hasardeuses serait se fourvoyer sur le terrain dangereux de la spéculation. Ainsi, les pourcentages de notre Tableau, établis sur une récolte intense de courtilières jamais égalée auparavant, n'interprétent que le résultat de nos constatations.

TABLEAU INDIQUANT LES

DES *GRYLLOTALPA GRYLLOTALPA* L., *GRYLLOTALPA AFRIC*

RECUEILLIS DURANT L

Antoine Cassab

PROVINCE	1933				1934				1935				19	
	POURCENTAGE				POURCENTAGE				POURCENTAGE				POURC	
	Gryllotalpa gryllotalpa		*Gryllotalpa africana*		*Gryllotalpa gryllotalpa*		*Gryllotalpa africana*		*Gryllotalpa gryllotalpa*		*Gryllotalpa africana*		*Gryllotalpa gryllotalpa*	
	Forme macroptère	Forme brachyptère	Forme macroptère	Forme brachyptère	Forme macroptère	Forme brachyptère	Forme macroptère	Forme brachyptère	Forme macroptère	Forme brachyptère	Forme macroptère	Forme brachyptère	Forme macroptère	Forme brachyptère
Alexandrie	7.75	92.25	—	—	5.25	94.75	—	—	2.75	97.25	—	—	1.90	98.10
Port-Said	8.25	91.75	—	—	6.00	94.00	—	—	4.32	95.68	—	—	3.12	96.88
Suez	15.46	81.16	2.38	—	10.38	87.22	2.40	—	7.11	90.74	2.15	—	4.20	93.52
Damiette	9.36	90.64	—	—	5.93	94.07	—	—	4.25	95.75	—	—	3.39	96.61
Gharbieh	32.46	63.02	4.52	—	22.38	72.49	5.13	—	15.92	79.35	4.73	—	12.38	82.50
Sharkieh	42.38	54.36	3.26	—	31.26	64.88	3.86	—	24.15	72.13	3.72	—	14.03	82.07
Dakahlieh	44.53	52.13	3.34	—	37.05	58.95	4.05	—	27 61	67.61	4.78	—	20.17	74.95
Menoufieh	48.18	51.82	—	—	41.01	58.99	—	—	30.07	69.93	—	—	22.63	77.37
Béhéra	9.33	90.67	—	—	7.75	92.25	—	—	4.11	95.89	—	—	3.13	96.87
Calioubieh	37.13	60.45	2.42	—	28.18	69.31	2.51	—	21.32	75.75	2.93	—	18.23	79.09
Ghizeh	37 56	41.12	21.32	—	27.33	51.54	21.13	—	20.15	59.22	20.63	—	9.54	72.03
Béni-Souef	34.72	41.13	24.15	—	30.02	45.89	24.09	—	27.71	48.01	24.28	—	22.18	52.99
Fayoum	24.15	33.58	42.27	—	20.31	37.17	42.52	—	17.13	42.48	40.39	—	15.01	41.95
Minieh	33.52	37.13	29.35	—	30.01	41.40	28.59	—	26.18	44.98	28.84	—	20.04	51.83
Assiout	34.75	35.11	30.14	—	30.39	39.58	30.03	—	27.14	43.33	29.53	—	21.15	50.43
Guirgheh	24.16	39.15	36.69	—	20.48	43.51	36.01	—	18.02	46.86	35.12	—	16.23	48.91
Kéna	27.18	42.13	30.69	—	22.04	47.06	30.90	—	19.81	49.78	30.41	—	17.13	53.70
Assouan	24.39	43.28	32.33	—	20.83	46.90	32.27	—	18.03	50.07	31.90	—	17.83	50.13

OURCENTAGES RESPECTIFS

A P. DE BAUV. ET DE LEUR FORME BRACHYPTÈRE

S ANNÉES 1933 A 1940

		1937				1938				1939				1940			
AGE		POURCENTAGE				POURCENTAGE				POURCENTAGE				POURCENTAGE			
Gryllotalpa africana		*Gryllotalpa gryllotalpa*		*Gryllotalpa africana*		*Gryllotalpa gryllotalpa*		*Gryllotalpa africana*		*Gryllotalpa gryllotalpa*		*Gryllotalpa africana*		*Gryllotalpa gryllotalpa*		*Gryllotalpa africana*	
Forme macroptère	Forme brachyptère	Forme macroptère	Forme brachyptère	Forme macroptère	Forme brachyptère	Forme macroptère	Forme brachyptère	Forme macroptère	Forme brachyptère	Forme macroptère	Forme brachyptère	Forme macroptère	Forme brachyptère	Forme macroptère	Forme brachyptère	Forme macroptère	Forme brachyptère
—	—	1.04	98.96	—	—	0.72	99.28	—	—	0.48	99.52	—	—	0.16	99.84	—	—
—	—	2.08	97.92	—	—	1.62	98.38	—	—	1.08	98.38	—	—	0.67	99.33	—	—
.28	—	3.15	94.67	2.18	—	2.67	95.07	2 26	—	1.75	95.99	2.26	—	1.00	96.14	2 86	—
—	—	2.03	97.97	—	—	1.28	98.72	—	—	0.92	99.08	—	—	0.69	99.31	—	—
.12	—	9.53	85.61	4.86	—	6.39	88.70	4.91	—	4.11	91.16	4.73	—	2.53	92.84	4.63	—
.90	—	10.14	85 81	4.05	—	7.42	88.43	4.15	—	5.03	90.77	4.20	—	3.06	92.06	4.88	—
.88	—	12.43	82.75	4.82	—	9.08	86.09	4.01	0.82	6.39	88.29	3.81	1.51	3.79	90.23	3.90	2.08
—	—	16.08	83.92	—	—	11.15	88.85	—	—	7.42	92.58	—	—	5.01	94.99	—	—
—	—	2.08	97.92	—	—	1.13	98.87	—	—	0.81	99.19	—	—	0.62	99.38	—	—
.68	—	11.02	85.83	3.15	—	8.01	88.33	2.94	0.72	5.71	90.07	3.04	1.18	3.02	92.27	2.99	1.72
.43	—	6.17	74.71	19.12	—	4.43	77.31	17.32	0.94	3.20	78.13	17 45	1.22	2.03	79.74	16.26	1.97
.33	—	19.16	55.71	25.13	—	15.83	59.11	25.06	—	13.54	62 20	24.26	—	9.07	66.80	24.13	—
3 04	—	12.83	45.08	42.09	—	9.76	47.71	42.53	—	7.16	50 65	42.19	—	5.21	51.87	42.92	—
.13	—	17.04	55.43	27.53	—	14.88	57.10	28.02	—	11 05	61.12	27.83	—	8.01	64.96	27.13	—
.42	—	18.68	52.40	28.92	—	15.09	56.00	29.01	—	11.78	60.53	27.69	—	9.08	63.19	27.73	—
.86	—	15.41	49.57	35.02	—	13.28	51.61	35.11	—	10.91	55 03	34.06	—	7.13	59.75	33.12	—
.17	—	15.22	55.20	29.58	—	13.62	57.46	28.92	-	11.09	58.87	30.04	—	9.01	60.97	30.02	—
.04	—	12.62	52.15	32.23	—	13.71	54.43	31.86	—	11 63	56.24	32.13	—	10.02	57.89	32.09	—

Note on the Poison-bait used in Egypt for controlling Locusts and Grasshoppers

by Mohamed Hussein
Locust Investigator, Ministry of Agriculture, Egypt

Sodium arsenite is used extensively in Egypt in the preparation of poisoned bran-baits for combatting the Desert Locust, *Schistocerca gregaria* Forsk., as well as many indiginous species of grasshoppers, mainly the berseem (*Trifolium alexandrinum*) grasshopper, *Euprepocnemis plorans* Charp., and the rice grasshopper, *Aiolopus strepens* Latr..

The formula of the bait is :

Sodium arsenite	2.5 lbs.,
Water	2.5 litres,
Molasses	4.5 litres.

The first ingredient should contain no less than 82 % water soluble arsenious oxide ($AS_2 O_3$) and molasses 45 to 50 % of cane sugar.

This concentrated poison is diluted at the rate of 1 : 15 of water; one diluted litre is sufficient for moistening about 0.9 lbs. of wheat bran. Thus, a ton (1000 kilogrammes) of bran requires 1125 litres containing 27.5 lbs. of sodium arsenite (= 12.375 kilogs.).

With the exception of emergency cases which necessitate the preparation of the concentrated poison bait on the spot, this solution is stored in drums or tins of different capacities and when required it is added to the bran after being diluted at the proportions already given.

It was found, however, that storage has a pronounced bad effect on the solution; chemical reactions take place separating the soluble arsenious oxide of the sodium arsenite into insoluble arsenious or arsenic oxide.

The longer the concentrated solution is kept the less effective it becomes. Samples taken from a 4 gallons tin were analysed after about 3 years storage. Half their original content of soluble arsenite was converted into insoluble arsenious oxide.

Many difficulties were moreover encountered in transporting molasses

or the prepared solution to the field, more especially to desert regions. Some authorities advocated the addition of molasses to the bait as a locust attractant.

Experiments were carried out during the last three years at Dokki by the Locust Research Sub-Section of the Entomological Section to ascertain this and two other points:

(1) To find out the minimum lethal dose of sodium arsenite for adults and for the different nymphal instars of the three species already mentioned.

(2) To find out the quantity of diluted solution necessary for moistening a certain weight of bran.

Space does not allow giving details of the technique of work followed.

Briefly speaking, laboratory experiments were conducted on locusts and grasshoppers kept in breeding cages of different dimensions and in partitions of the big locust cage covering an area of about 750 square metres. No food was given 12 hours before giving them bait.

The bait was applied in the morning sometime between 7 and 9 varying with the seasons. These are the morning hours on which locusts and grasshoppers start feeding (Temp. 20° C.).

Field experiments were carried out when *Schistocerca gregaria* Forsk. invaded and bred in some localities of the South-Eastern Desert in the vicinity of Asswan. Bait with no molasses was applied on a small scale; the large quantities of the sweetened concentrated solution which remained from the 1937 invasion had to be used for their control.

Results so far achieved show that:

(1) Molasses cannot be regarded as an essential ingredient in the poisoned bait.

The bait made from wheat bran, sodium arsenite and water gave as high percentage of mortality as the bait with molasses.

In both cases, the sodium arsenite was added at the rate of 1 : 100 of wheat bran and the mixture was thoroughly moistened with water.

(2) When dealing with *Schistocerca* hoppers in the first two nymphal instars, 0.5 gram of sodium arsenite added to every 100 grams of bran gave a good mortality after 72 hours in the majority of cases and after 48 in some experiments.

This was also observed with hoppers of the same stages in *Euprepocnemis plorans* Charp. and *Aiolopus strepens* Latr..

(3) As regards the quantity of water added to the bait it was found that no less than 1.5 c.cms. of water should be added to every gram of wheat bran.

It seems that water plays an important role in attracting the hoppers and locusts especially in desert regions.

In 1928, while combatting both these species of grasshoppers in the

Dakhla and Kharga Oases in the South Eastern Desert, I noticed that hoppers and adult grasshoppers hardly fed on the bait which had become dry by the strong wind.

In some of the experimental cages bran was remoistened and the insects soon devoured it.

The same observation was made in the Sinai Peninsula during 1930 invasion when barriers of bran bait (containing molasses) were scattered in the path of the marching hopper bands. On becoming dry, water had to be sprinkled over them to induce these creatures to feed on the bait.

Finally, reference should be made to another substance used instead of sodium arsenite, namely sodium fluosilicate.

The importation of sodium arsenite under the present war conditions became very difficult and a substitute of this material had to be used.

Several experiments carried out with sodium fluosilicate have definitely shown that it can be regarded as a good substitute. The dose used is however high.

Experiments have so far shown that for *Schistocerca* hoppers in the first and second stages the proportion should be 2 : 100 of bran.

For hoppers in a more advanced stage and adults 4 : 100 must be used.

Further experiments are being carried out.

BULLETIN

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